RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

BRIDGES - BUILDINGS - CONTRACTING - SIGNALING - TRACK

New Series, Vol. IX Old Series, Vol. XXVIII | Chicago | MARCH, 1913 | New York | No. 3

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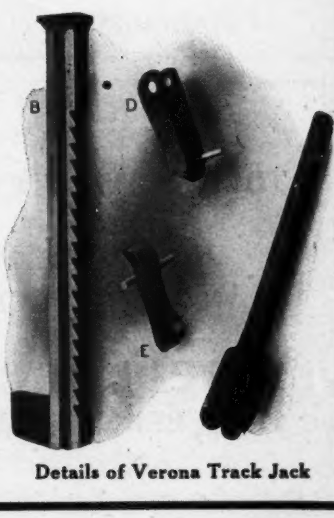

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BRIDGES—BUILDINGS—CONTRACTING—SIGNALING—TRACK

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CONTENTS.

Boarding Company Employees

ONE OF THE fruitful causes of discontent among railway laborers is the present method of boarding extra gang men. Two general methods have been used, each of which has serious draw backs.

Foreign laborers frequently pay an interpreter for their board and lodging. The interpreters pay rent for the cars and are furnished stoves and bunks by the railway company. All these things result to the advantage of the interpreter who charges a liberal rate and pockets the difference. Many times the railway company also pays one or two cooks for the gang, men who never leave the camp.

Many railway officials have deplored this state of affairs but say it is necessary in order to obtain and hold laborers. If the facts are carefully considered, they will show that all these concessions are made *to retain interpreters.* The board which foreigners have, if they are fed by an interpreter, is usually not sufficiently ample and strengthening to enable a man to do a good day's work. Another way in which poor food is foisted on these men at exorbitant prices, is to have the labor agent reserve the privilege of furnishing food to these men. This condition is about the worst of all, as the labor agent has only one object in view, and that to obtain the most money from the men. He buys the cheapest supplies and sells them far above market prices.

The foreigners buying supplies or board in either of these ways, are likely to be half starved at rates which would pay for fairly good board. Even when a small gang of laborers buys and cooks its own food, they are liable to stint themselves in order to hoard up more money.

If the railway company should furnish good board for this class of labor, and force them to eat in the camps, much better results could be attained at little increase in cost. Provided, of course, the company kept the camp under supervision of a careful, competent and honest man.

Where hobo labor is employed, the boarding contract is usually let out to a boarding contractor. The purchasing agents for most of these concerns have a knack of picking up all supplies which have been rejected by every other consumer. Many times purchases will be made, the price being next to nothing, of stores which are just on the verge of spoiling, and which have to be shipped and consumed quickly or be entirely spoilt. The cheapest of everything is the slogan of these men and unless they are kept under constant and strict supervision from the railway company, the board given is such as to drive away the men from the camp.

If one of these companies could see the advisability of feeding men properly, its services would probably be in great demand. It many times appears as if some high authority were upholding one of these concerns to the great detriment of the labor forces. Such support can only be explained by personal friendship or a consideration.

A company boarding department could eliminate many of these objectionable features, if conducted properly. The one great objection is that in case the company does board its own laborers, they will be inclined to blame the foreman for everything about the camp which is not entirely satisfactory, and this would tend to decrease the amount of work done.

However, it is the common practice of hobos to blame the

company anyway, in case the camp is unsatisfactory, so that there would be no great difference in this respect. And in addition, the laborer could be fed properly at a satisfactory rate, and he would be able to do a hard day's work each day. Most contractors feed their men with entire satisfaction, some of them running this department at a loss because the increased amount of work from the men warrants it.

Editorial Policy

T is the primary object and purpose of *Railway Engineering* to secure and publish for the benefit of its readers, technical articles only, and, in general it does not profess to disseminate "news," except, possibly in the personal columns. Consideration of the subject will quickly convince anyone that a monthly publication cannot treat much of its matter from a news standpoint. It is practically impossible, on account of lack of space, to describe or attempt to describe in one issue, a dozen or more large engineering works, which are finished in a certain month. When circumstances like that arise, some of the articles must be held up and published the following month and possibly two or three months or more after competition of the work.

It is deemed advisable to cover each subject thoroughly, and extensively if necessary, rather than to publish a much larger number of articles, too brief to be of greatest value to the reader.

For the reasons given above—a monthly publication, limited space, and the desire to treat matters comprehensively, yet exactly—it is probable that descriptions of certain works will appear from time to time in other publications, previous to its appearance in these columns.

It is frequently necessary to hold up a submitted article, or one prepared from data submitted, while obtaining more information about parts which it is believed are necessary to give the article greatest value.

Because an article has already appeared elsewhere is no reason why *Railway Engineering* should deprive its readers of a description of the same work, prepared from data submitted to us in its original form.

In abstracting from papers given before engineering societies, etc., it is our purpose to use only those which we believe to be of exceptional value, and even in these cases it is deemed advisable in general to condense the article into the smallest space possible without detracting from its value.

Safety First Signs

THE "SAFETY FIRST" bureau has become an established necessity on all of the larger systems. No longer an experiment in itself, the bureau now is in a sense, one of experimentation. Its greatest and most important duty is that of educating both employees and the traveling public. Signs, mottoes and exhortations posted about railway property and in rolling stock are the results of the "safety first" bureau's earliest efforts in this direction. These signs are of heterogeneous design and wording and to those most in need of their teaching, they mean nothing.

The transient foreign laborer and the ignorant traveler are most in need of the caution, lesson, or direction intended to be conveyed by the posted sign. The importance, therefore, of general standardization in this branch of effort, is paramount. Considering, as an example, the most common and the most important of safety signs, "danger" or that next in importance "caution" the color scheme and wording should never vary, proportions should be kept the same no matter what the size. Red has long been regarded as a universal danger warning. This fact is due to its use by railways, as a stop signal, since the beginning of their existence. A suggested universal standard danger sign is based upon the strongest color scheme known, black, red and white. A standardized arrangement of these colors could never be mistaken by the most ignorant, once translated. Permanency and resistance to defacement are also qualities to be insisted upon in standardization of signs. Enameled metal is generally considered as the best means of fulfilling these requirements. A system of inter-railway standards may be carried so far as to specify the locations for certain signs.

General economy and a better functioning of the "safety first" movement will result from consistent and cooperative study of this subject in all departments, with an early application of principals. Several state legislatures have considered bills covering this subject and unless there is standardization in advance of legislation, the very ends coveted will be defeated through the variance of state laws.

Troubles with Electrolysis

EVIDENCE of the pernicious effects of electrolysis has been discovered in the concrete incased steel structural members of train sheds, and buildings in at least one electrically operated railway terminal. The situation is so alarming that expert electrical engineers have been engaged solely in inspection work in the hope of locating deteriorating parts in time to arrest the dangerously devastating results of electrolysis. In the meanwhile other men are constantly working to control all stray electric current by perfecting the bonding and return lead system.

This situation, while hardly one to be ordinarily expected, must be considered in electrification plans.

The use of large amounts of current under fairly heavy voltage calls for the greatest of care in its return to the power house. The problem, simple enough in open country, becomes most perplexing in the congested terminal located in the city practically living on electricity of a multiplicity of voltages and amperages.

In the case above mentioned, the fact that even the spikes in the tracks were destroyed in a few months' time, does not lend much to the danger of the situation, for it is the uncertainty with regard to the condition of the enclosed structural steel, which worries the railway officers. Greater knowledge of ways and means of governing and controlling stray currents is imperatively needed by those responsible for large terminal electrification projects.

The International Rys. of Central America have ordered 20 general service cars from the Ralston Steel Car Co.

The Louisiana & Northwest has placed an order with the Barney & Smith Car Co. for 2 wooden coaches.

The Norfolk & Western, it is reported, will build 6,500 cars in its own shops.

New Delaware River Bridge at Yardley, Pa.

Philadelphia & Reading Railway Co.

By E. Chamberlain, Assistant Engineer.

The Philadelphia & Reading Ry. has about completed a double track concrete arch bridge across the Delaware river near Yardley, Pa., on the New York Division. The new bridge parallels and is 35 feet down stream from the present old structure, which it will replace and which will be dismantled after the new arch bridge is put into service.

The old bridge, which is made up of 7 pin connected and 2 plate girder deck spans, carrying two tracks, was built jointly by the North Pennsylvania Railroad Co. and the Delaware & Bound Brook Railroad Co. The bridge was erected in 1875 and opened for traffic in May, 1876, and has been in continuous service since that date. It was, however, strengthened in 1883 by an addition of 50 per cent to the trusses and 100 per cent to the floor system by the introduction of a middle truss.

The new bridge consists of 14 arches, 11 of which have 90 ft. 9 in. spans and 3 of which have 85 ft. 11 in. spans. The total length between ends of abutments is 1,445.5 ft. The bridge is built on a rising grade to the eastward of 0.22 ft. per 100 ft., is 33 ft. wide from out to out of coping, with tracks on 13 ft. centers. The base of rail is about 70 ft. above low water in the river and about 80 ft. above bed rock.

The arch ring is a five centered design having a rise of 35 ft., a crown thickness of 3 ft. 6 in. and a radial thickness at the junction of each arch, over the piers, of about 13 ft. 6 in.

Two lines of reinforcing rods are embedded in the arch rings, one line at the intrados and the other at the extrados, each being ¾ in. square twisted, spaced on 7 in. centers. These were tied in with transverse rods ½ in. square, spaced on 3 ft. centers.

The piers are of the type shown, the center or abutment pier having a width of 20 ft. and the intermediate piers a width of 10 ft. at the springing line. The ends are symmetrical in shape, having cut-water extensions, the up-stream noses of Piers Nos. 2 to 11 inclusive being protected by a bent plate 18 in. wide by ½ in. thick anchored to the pier by 12 by ¾ in. round swedged bolts. The side and end faces of the piers have a batter of ½ in. to the foot. This section is capped by a coping course 11 ft. wide and 2 ft. thick, the top of the coping being about 4 ft. below the springing line of the arch.

The spandrel walls are designed as gravity sections and are also reinforced with vertical rods ¾ in. square and twisted, spaced 4 ft. center to center.

The pilasters are carried above the base of rail about 5 ft. and extend beyond the face lines of the arches, providing refuge bays at the track level, and together with the intermediate concrete posts and two lines of 4 in. galvanized iron pipes, form a very substantial and effective railing.

Embedded in each of the spandrel walls is a 4 way vitrified clay conduit with manholes placed at frequent intervals to carry the present and future lines of telephone and telegraph wires, instead of attaching them to the outside of the bridge.

The drainage of the bridge is taken care of by means of an 8-in. cast iron pipe, extending from the valleys over the piers to the soffit of the arch.

The spandrel filling is composed entirely of one and two men size stone carried to the sub-grade of the roadbed.

Yardley Bridge, Philadelphia & Reading Ry.

The water-proofing of the arches is composed of five layers of Hydrex felt protected by a layer of hard bricks thoroughly mopped, applied to the tops of the arches between the spandrel walls, flashed up the inner faces of the spandrels about 12 ins. except directly over the piers where the flashing extends 4 ft. above the tops of the arches. All vertical expansion joints and horizontal construction joints are protected by a single layer of prepared burlap 12 in. wide thoroughly mopped with asphalt compound. This burlap is carried up under the coping at all expansion joints.

The contract for the work was let to the Talbot Construction Co., of New York City, in April, 1911. Included with the river bridge contract was the extension of the masonry of the bridge crossing the tracks of the Belvidere division of the Pennsylvania R. R., and the feeder of the Delaware and Raritan canal. This extension was made necessary by the change of alignment across the river. On May 15th the contractors began to assemble their plant in preparation for starting the work, but it was nearly two months before they were prepared to make a start on the foundations in the river, and on July 21st the first concrete was deposited on bed rock for the foundation of Pier No. 2.

Construction Plant.

The contractors decided to conduct the work from both sides of the river and for this purpose duplicate plants were installed near either end of the bridge, as shown upon the accompanying plan.

The materials used in the Pennsylvania half of the bridge were shipped over the Philadelphia & Reading Ry. to a siding at the grade elevation of the main tracks and dumped from the cars into chutes, by which the materials (sand and pebbles), were conveyed to storage piles, and the cement to storehouses at the base of the main track embankment. The height of this embankment (about 45 ft.) afforded unlimited capacity for the storage of materials at practically no additional cost for rehandling. The cement house, with a capacity of 14 cars, had a narrow gauge track laid on the floor, upon which a car containing a skip holding 50 bags was operated to serve the mixer, which was about 100 ft. distant. This skip was hoisted from the car to the charging platform by the supply derrick, which delivered the pebbles and sand to the mixer bins.

The mixing plant on the New Jersey side of the river was located along the Belvidere division of the Pennsylvania R. R., over which road all the materials for this half of the bridge were shipped and delivered to a siding connection leading to the mixing plant and storage piles. A derrick operating a clam-shell bucket unloaded the cars and delivered the concrete materials either to the mixed bins or to storage piles. The mixing plants were similar in construction and of the enclosed cube type, sufficiently elevated on a timber frame work to dump the mixture into cars or into buckets on flat cars. The mixers were belt connected to horizontal steam engines. Above the mixer were the measuring and supply bins, the latter having two compartments, one for stone, with a capacity of 22 cu. yds., and the other for sand, with a capacity of 14 cu. yds. The water for mixing was supplied through the main shaft of the cube, which is hollow and connected to the supply tanks. The amount of water is regulated by the number of turns made.

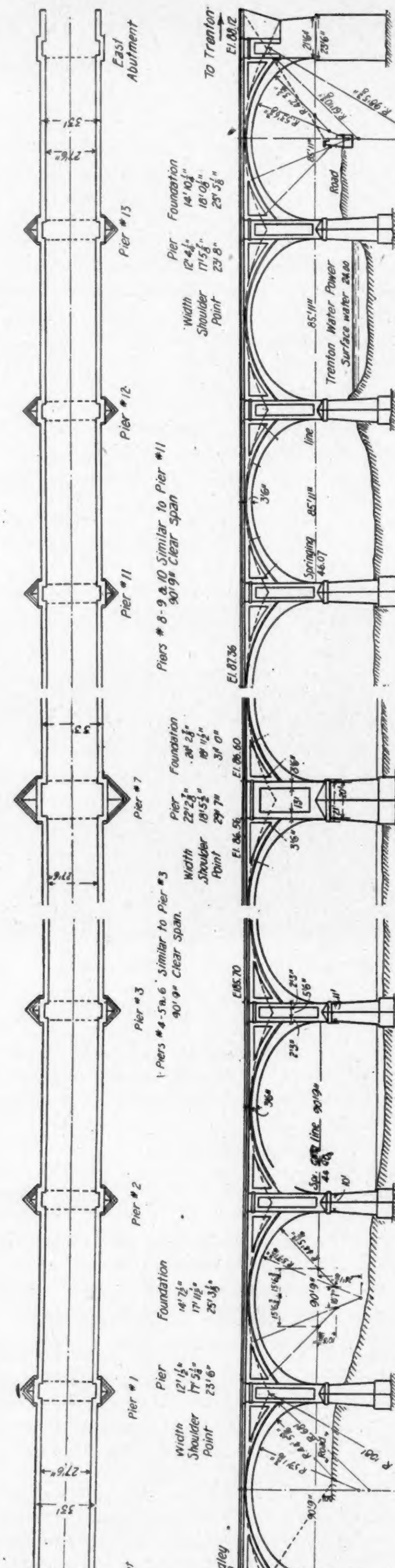
The maximum capacity of the mixers was about 25 batches of 1.6 cu. yds. per hour, but this speed was not attained at any time during the work. The transportation facilities were the limiting features, and while they handled 20 or 22 batches per hour for one or two hours, the average for the day would fall around 15 or 16 batches. The distance from the mixers to the work was a handicap in the progress of the work.

The construction work on the Pennsylvania side of the river was carried on from a temporary pile trestle, built on the center line of the new bridge and reaching to the middle of the river at Pier No. 7, the piers being numbered from the Pennsylvania side. This trestle was composed of 5-pile bents spaced about 10 ft. centers and capped with 12 by 12-in. timbers, with 3 by 12-in. cross bracing. The stringers generally were of 12 by 16-in. timbers upon which were placed 3 by 12-in. planks to which the rails were spiked. It supported a 20-ft. gauge track for the operation of a steel traveling crane which was used in placing the coffer-dams, in excavating the pier foundations, and in placing the concrete from the flat cars into the foundations or forms. It also supported a narrow gauge track used in transporting concrete, etc., by small locomotives from the mixing plant, located about 500 ft. back from the river shore.

On the New Jersey side construction was handled by a series of stiff-leg derricks, placed south of the bridge and midway of the piers, so that each derrick served two piers. These were used in handling the excavation and the placing of materials in the piers. A temporary trestle extended into the river to a point between Piers Nos. 8 and 9. This track extended back to the mixing plant and was about 1,200 ft. in length.

The piers were completed to the springing line of the arches from the river trestle and stiff-leg derricks.

On the Pennsylvania side the work of completing the piers began with No. 7 pier and as each succeeding pier was completed it was necessary to abandon the river trestle between the completed piers. While this part of the work was



Elevation and Plan of Yardley Bridge.

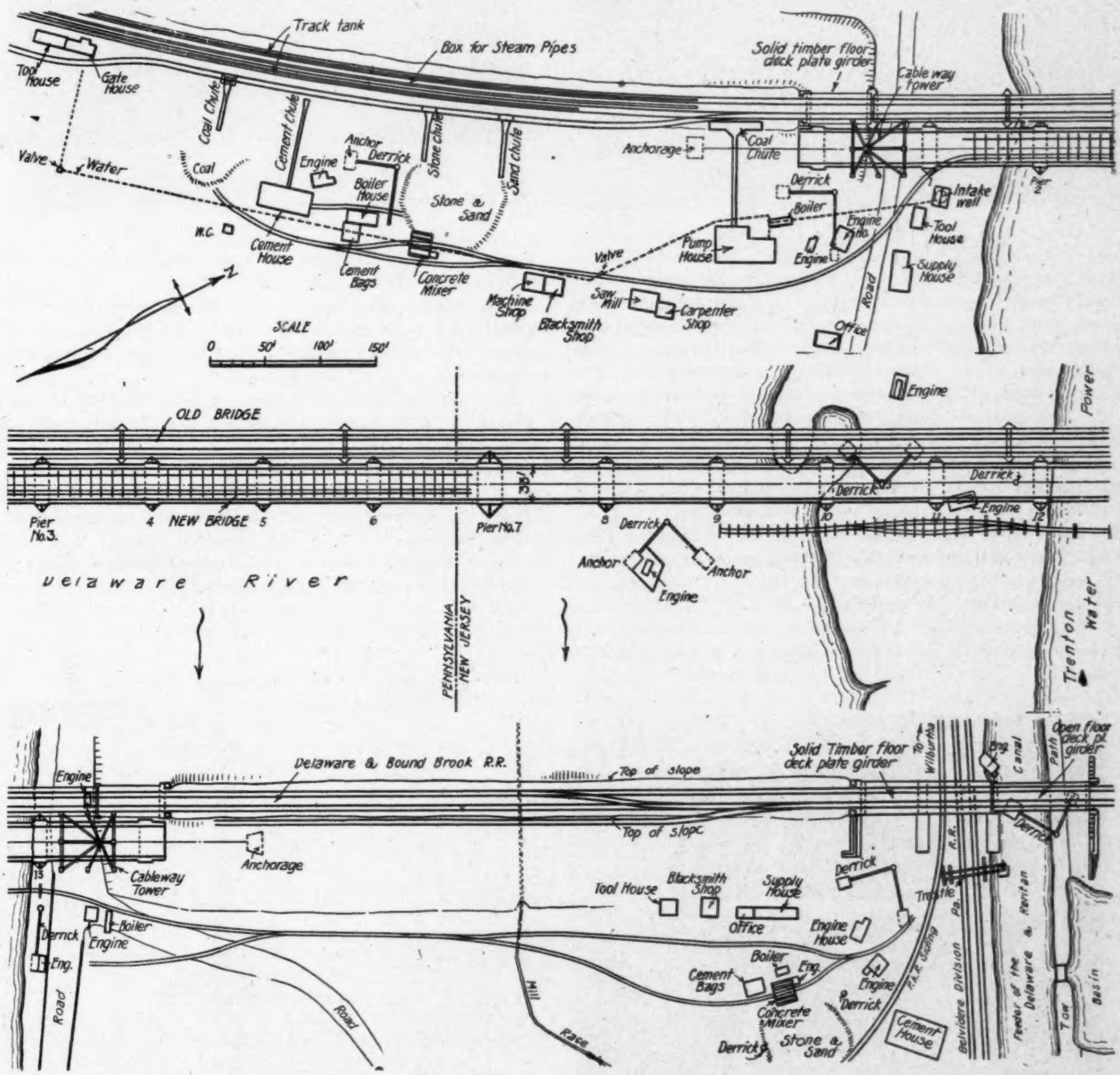
progressing, a cable-way was being installed on the center line of the bridge, with towers 125 ft. high. The Pennsylvania tower was located between the Western abutment and Pier No. 1 and the New Jersey tower between Pier No. 13 and the eastern abutment, making a clear span of 1,320 ft. The towers were built of long leaf yellow pine lumber and were supported on concrete foundations. They were composed of eight 12 by 12-in. posts to a height of 78 ft., and four posts for the remainder of the distance to the top. The bracing was 3 by 12 in. throughout. A saddle, at the top, of three 12 by 14 in. by 6 ft. oak timbers supported the cable. A total of about 28,000 ft. B. M. of lumber was used in each of these towers. The main cable was 1¾ in. in diameter, made up of six strands of 19 wires each, of plow steel with an ultimate strength of 112 tons. The cable was supported on an A frame at the center pier dividing it into two spans, each of which was operated by a 50 H. P. double cylinder, double friction drum hoisting engine, made by the S. Flory Manufacturing Co., of Bangor, Me.

The cable-way was used for the remainder of the concrete work above the springing line of arches and in placing the forms and centering.

In building the spandrel walls, the steel traveling crane operated from a track built on the completed arch rings, was used in connection with the cable-way.

Drop bottom buckets of 1¾ cu. yds. capacity were used throughout the work.

A portable steam saw mill manufactured by the American Saw Mill Co., of Hackettstown, N. J., carrying a 44-in. circular saw, was installed by the contractors, and has proved a great economy in resawing the heavy lumber required in the early part of the work, into smaller sizes for use in the pilaster and spandrel wall forms.

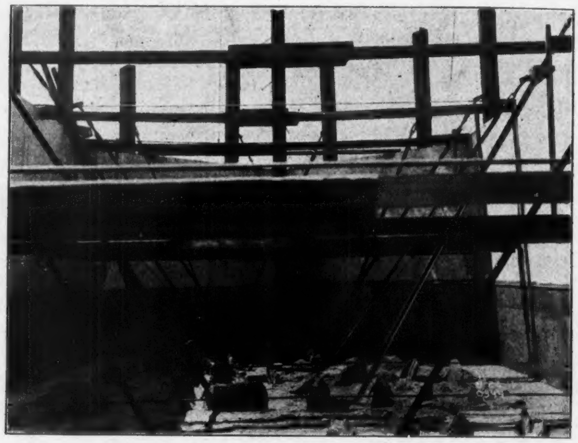


Layout of Bridge and Construction Plants.

Foundations.

The foundations for the abutments and piers were all carried to bed rock. The abutments were originally designed to be built on concrete piles driven to rock. This construction was adopted on account of the proximity of the new abutments to those of the old structure and the fact that the western abutment was founded about 30 ft. above rock, and the eastern abutment only about 20 ft. About 30 piles were driven to the gravel in the western abutment and in each case it was impossible to penetrate further. The piles were badly broomed at the ends and several were brok-

Rock Bottom, One of the River Piers.



Interior Bracing of Forms, Showing Turnbuckles for Adjusting and Keeping Forms in Line.

en and sheared off below the surface. It was deemed unwise to proceed with this construction and arrangements were made to excavate to rock. For this purpose 40 ft. lengths of Lackawanna steel sheet piling, having ½-in. webs, were driven on the outside lines of the abutment. These were successfully driven to rock. The southern half of the abutment was first completed to provide means for bracing the old masonry during the construction of the northern half. The method of carrying on the work is shown in the accompanying drawing. Before making the excavation, trestle bents were placed under the present tracks in order to relieve the old masonry as much as possible.

There was a slight settlement of about 4 in. noticed in one end of the old abutment, but nothing more serious resulted. A great deal of water was encountered in the excavation and much of it had to be raised about 42 ft.

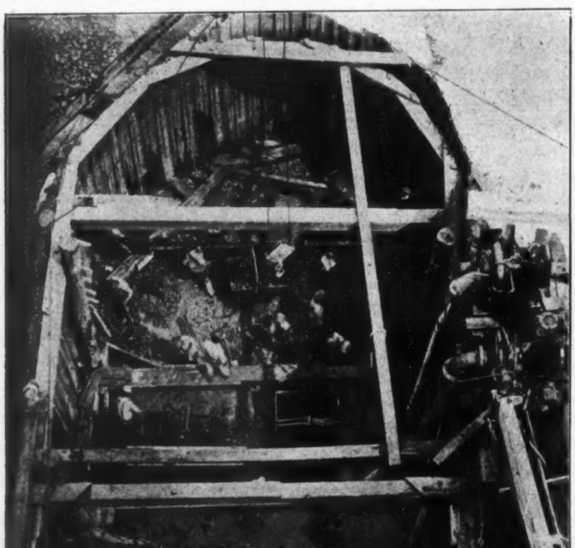
Two centrifugal pumps, one 10 in. and one 6 in. were used in unwatering the excavation. These were set about 18 ft. above the bottom and the discharge was piped about 24 ft. to the top of the excavation.

No attempt was made to drive the concrete piles at the eastern abutment and the same method of construction was used as at the western abutment to carry the foundation to bed rock.

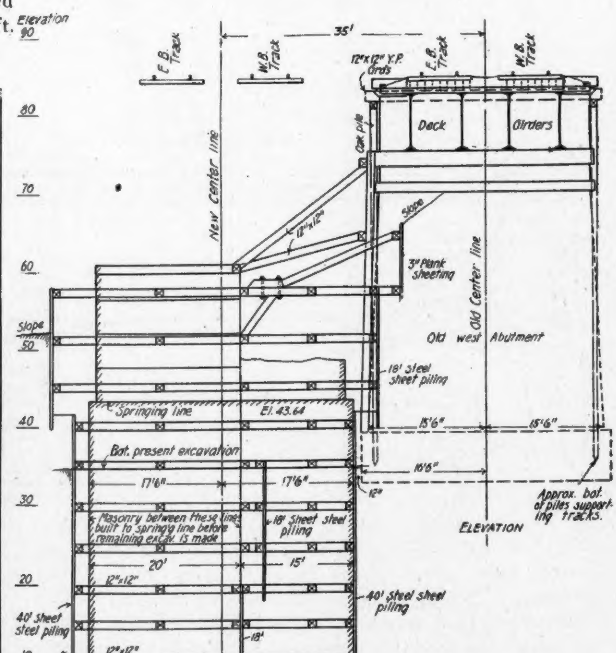
Steel sheet piling of the Lackawanna pattern, 12¾ in. wide, with ⅜-in. web, 18 ft. long was used for all the coffer-dams in the river.

The wooden piles for the construction trestle were driven so as to provide anchorage for the 12 by 12-in. timber templates, placed near the water level, around which the steel piling was driven.

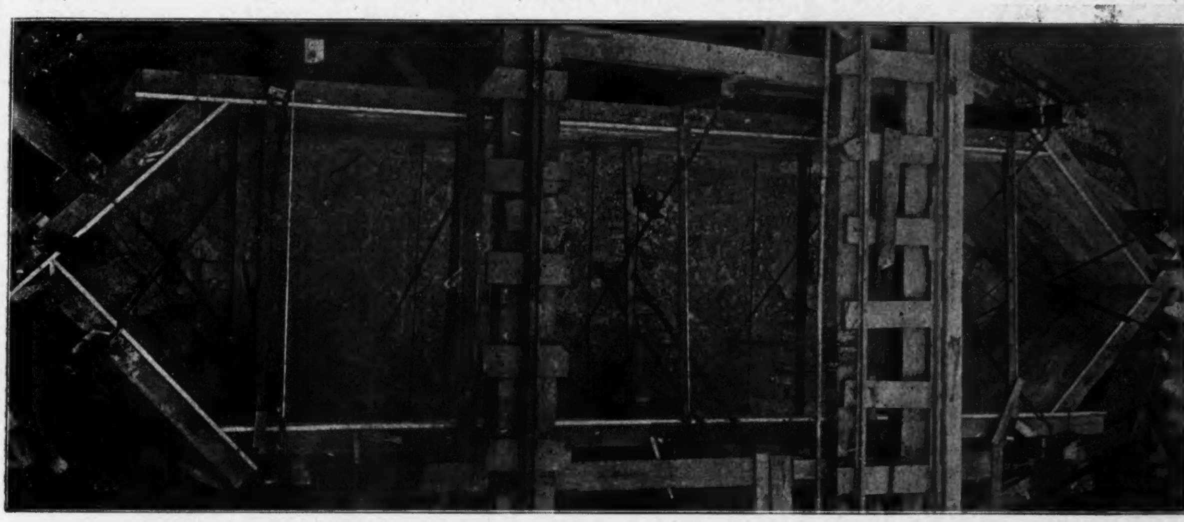
These templates corresponded to the outside lines of the masonry, the ends being made semi-circular, to form a con-



Looking Down into Cofferdam—Excavation in Progress.



Bracing of Pier Form to Old Masonry.



Pier Form, Looking Down, Showing Inside Bracing. Note Perfect Alignment of Forms.

tinuous line of locked sheet piling. The piling was set up against the timber template (which also served as walls) by the traveling crane or a stiff-leg derrick, and then driven to rock by means of a steam hammer of "New Monarch" pattern, having a steam cylinder 6¼ by 14 in. and weighing about 4,200 lbs.

The material in the river bed overlying the rock was a heavy gravel, sand, and boulders for an average depth of 8 ft. The depth of water at summer stage ran from 0 to 6 ft.

Most of the unwatering of the coffer-dams was done with two 6-in. pumps. Some difficulty was experienced at first in lowering the water, due to there being several feet of water in direct contact with the outside of the piling which caused considerable leakage into the dam. This was checked by placing burlap bags filled with earth against the outside of the piling, which proved very effective.

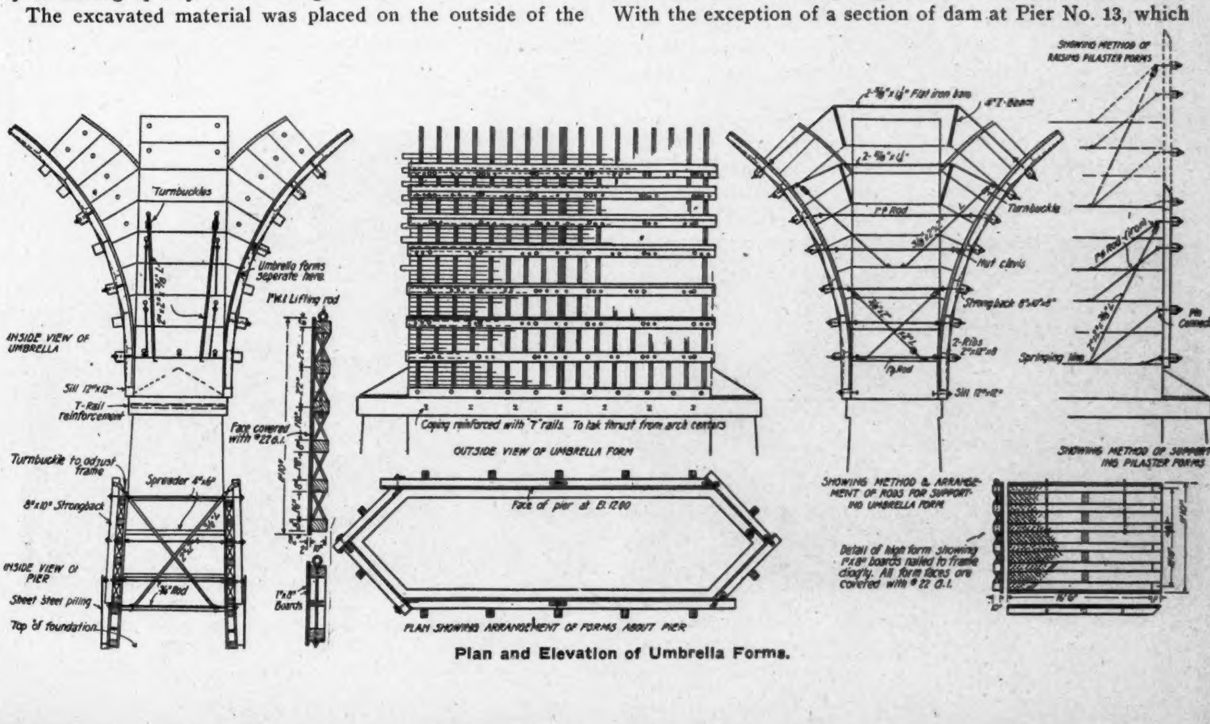
Long wire rods were used to puddle the gravel and silt along the outside of the joints, which assisted very materially in closing up any leaks through them.

The excavated material was placed on the outside of the dams, which also aided in reducing the leakage. As the excavation progressed, additional timbering and bracing was placed to support the sides of the dam.

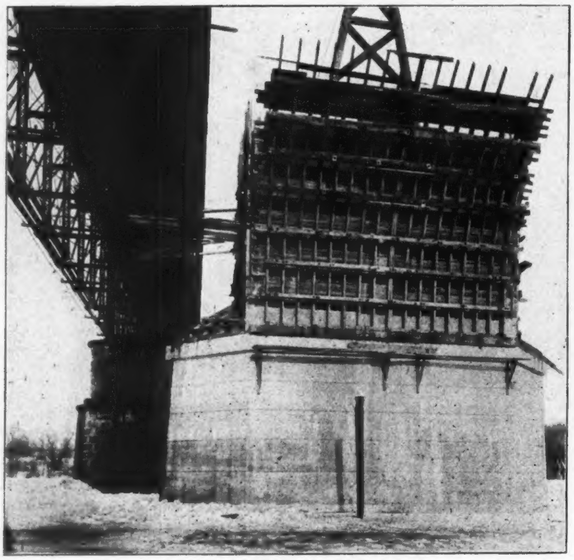
Although the piles in many instances penetrated the top strata of the shale rock some 12 or 18 in., a great deal of water came into the dams at the bottom of the piling and interfered with the placing of the foundation concrete.

The dams were about 24 in. wider than the neat foundation lines of the piers, and this space was taken advantage of in leading the water around the outside of the concrete to the pumps at the end of the dam. This was accomplished by leaning a form two planks in height against the steel sheet piling, leaving a space of about 12 in. at the bottom for the excess water.

Sufficient of the 18 ft. steel piling was purchased to cover five dams, or about 11,466 lineal ft. The first driving of five coffer-dams required about 11,160 lineal ft. The second driving of five dams required 10,980 lineal ft. and the third driving 11,460 lineal ft., or a total for the work of 33,600 lineal ft. Thus most of the piling received was used three times. With the exception of a section of dam at Pier No. 13, which



Plan and Elevation of Umbrella Forms.



End View, Umbrella Forms.

Side View, Umbrella Forms.

was allowed to remain to protect the bank of the Trenton Water Power Canal, all the 18-ft. lengths of piling were recovered.

The loss to the contractor by reason of the steel splitting open or bending or otherwise becoming damaged so as to be worthless for further use, did not exceed 5 per cent of the total, so that of the 637 pieces brought on the work 600 were recovered and available for use on other work.

Forms.

Great care was exercised in the construction and bracing of the forms and no materials were spared in their design. The justification for this was shown in the very small percentage of failures during the entire work, these being very slight and of minor importance. A failure in any of the umbrella forms might have been disastrous. As it was, no movement was noticed in any during construction.

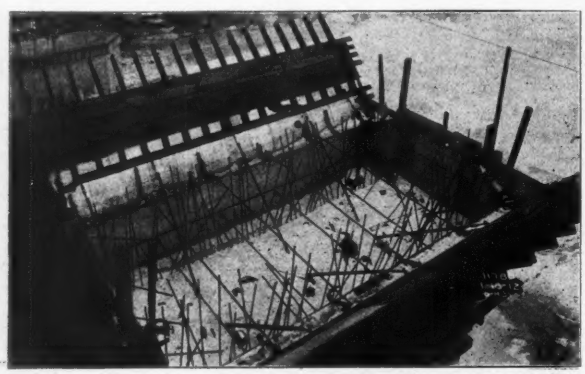
The forms for the piers were made up in sections measuring about 12 by 16 ft. These were composed of 8 by 10-in. horizontal timbers, spaced about 2 ft. C. to C., well braced, with two thicknesses of 1 by 8-in. boards, placed diagonally, for the lagging. Upon the face of the lagging was tacked No. 22 galvanized sheet iron.

These forms were assembled on the shore and placed in position with the derricks. They were held in position with ¾-in. rods and 4 by 6-in spreaders across the pier. Attached to the ends of the rods were wrought iron swivels, receiving the square nuts of stub bolts, which passed through the forms to outside wale pieces. The stub bolts extended several inches into the concrete and were removed to release the forms, leaving the bolt holes in the concrete to be closed with mortar, avoiding the necessity of cutting bolts and keeping all iron well back from the face.

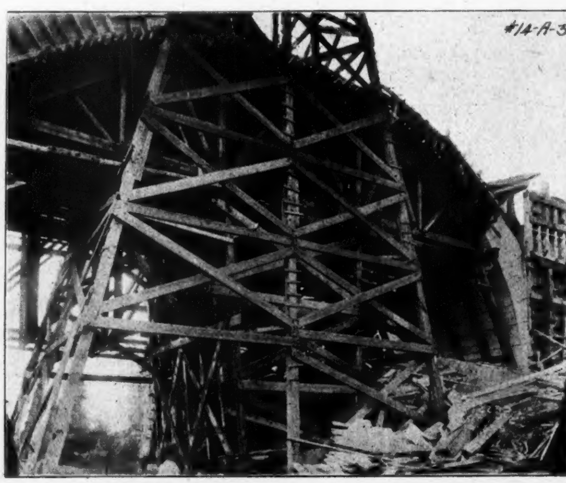
The forms were adjusted to line at the top by turnbuckles attached to the 2 by 2 by ⅜-in. angle iron cross braces which were anchored into the lower section of concrete previously placed.

The ribs for the umbrella forms were composed of 2 pieces, 2 by 8 in., spaced about 2 ft. C. to C. with 8 by 10-in. wales, spaced about 4 ft. C. to C. and secured to the ribs with ¾-in. iron stirrups. The lagging was 2 by 6 in. Practically the some method of inside bracing was used as for the main pier forms, except that it was heavier and closer together.

The main centers were as shown in the accompanying plan, having a clear span of about 70 ft., and were made up of seven ribs supported at the ends on inclined timber bents resting on the coping of the piers and suspended from the umbrella section by means of seven 1½-in. rods passing



Arch Centering. Inside Bracing for Umbrella Forms.



Cable Tower, Showing Interference with Arch Centering.

through the concrete to the back of the arch. The coping of the piers was reinforced with T rails to take the thrust of the loaded centers. The centers were supported at the middle by timber towers measuring 21 by 33 ft. at the base and founded upon 14 timber piles.

Four sets of oak wedges were used under each rib. The ribs were built in half sections for ease in erection. All the forms and arch centers were of short leaf yellow pine, and were designed by the contractors.

Concrete.

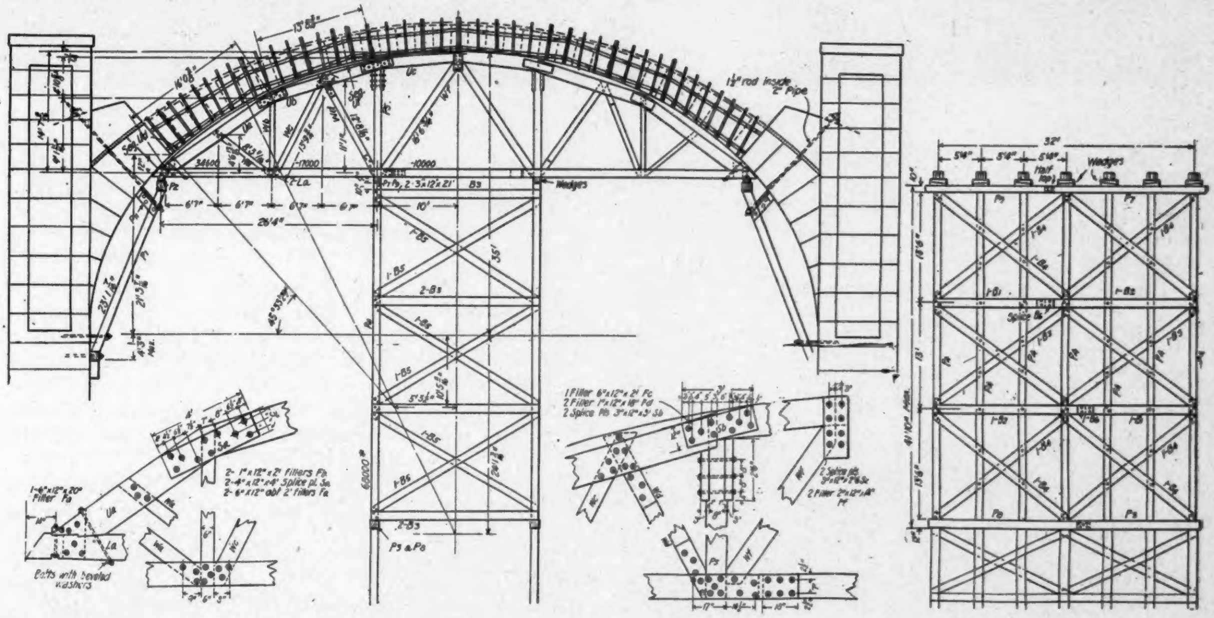
The concrete in the bridge was of two classes, 1:2:4 and 1:3:6 mixtures. 1:2:4 mixture was used in the first four feet of the foundations. From this point to the springing line of the arches the mixture was 1:3:6. The arches and spandrel walls were of 1:2:4 mixture. Embedded stones were allowed in the foundations and piers, but not in the arch rings or spandrel walls. One to two men size stone were used for this purpose, procured from a local quarry for the New Jersey side of the bridge, and limestone for the Pennsylvania side. The quantity of stone used varied in different portions of the work, depending upon the convenience to the stone piles and the ability of the derricks to handle the concrete and place it in the forms as fast as it reached them from the mixer. As it was necessary to use the same derrick for both concrete and stone, the stone was placed when convenient, the concrete having the preference.

The coping was composed of a 1:3:6 mixture and the railing posts of a 1:2:4, granolithic mixture. The stone for the posts was a ¼-in. size trap rock, cleaned of dust.

Dragon cement was used throughout the structure and every car received at the work was sampled and forwarded to the company's laboratories at Reading, Pa., for testing. The following table shows the average result of 40 tests:

Residue No. 100 Sieve Per cent	Residue No. 200 Sieve Per cent.	Mgo Per cent	SO_3 Per cent.	Specific Gravity	Initial Set (Hours)	Hard Set (Hours)	Steam and Hot Water Test	Tensile Strength Neat Test: One Day (Lbs.)	Tensile Strength Neat Test: One Week (Lbs.)	Tensile Strength ⅓ sand: One Week (Lbs.)
4.74	21.48	2.42	1.846	3.15	2.6	6.43	O. K.	472	698	357

The sand used for the concrete in the Pennsylvania side



Plan and Details of Arch Centering.

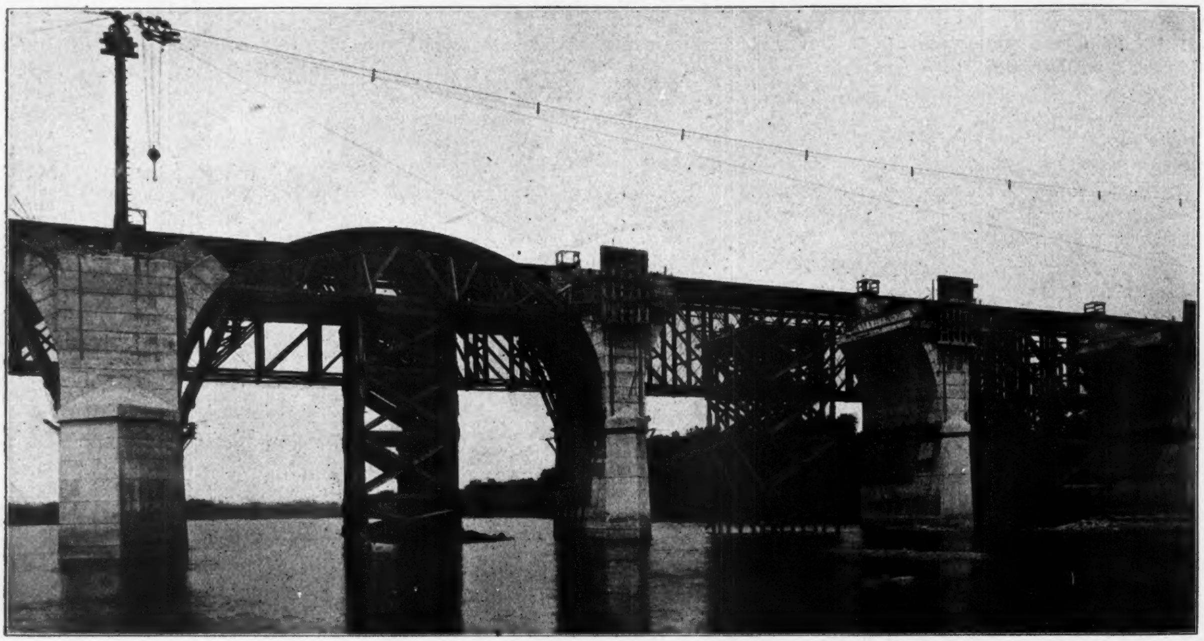
SCHEDULE OF TIMBER REQUIRED FOR ONE COMPLETE SPAN

REQUIRED	DENOMINATION	DIMENSION	MARKED	REMARKS	REQUIRED	DENOMINATION	DIMENSION	MARKED	REMARKS
28	Top Chord	4" x 16" x 16'6"	Ua	Y.P.	2	Plates (Caps)	12" x 12" x 20'	P8	Y.P.
28	"	3" x 16" x 14'	Ub	"	2	"	10" x 10" x 20'	P7	"
14	"	10" x 16" x 10'	Ue	Cut to radius "	2	"	10" x 10" x 16'	P9	"
28	Segment	4" x 10" x 16'	Ud	" " " "	7	Struts	12" x 12" x 6'	P11	Cut to lengths at job "
28	"	3" x 6" x 14'	Uf	" " " "	4	Bracing	3" x 12" x 14'	B1	"
28	Lower Chord	4" x 12" x 32'	La	"	4	"	3" x 12" x 19'	B2	"
7	Tie	6" x 12" x 16'	Lb	"	64	"	3" x 12" x 21'	B3	"
14	Diagonals	6" x 6" x 9'	Wa	"	16	"	3" x 12" x 22'	B4	"
"	"	6" x 6" x 10'6"	Wb	"	42	"	3" x 12" x 24'	B5	"
"	"	6" x 8" x 14'	Wc	"	1	"	3" x 12" x 16'	B6	Cut to lengths at job "
"	"	6" x 8" x 14'	Wd	"	10	Fillers	6" x 12" x 12'	Fa, Fe, Fg.	" " " " " "
"	"	6" x 10" x 16'6"	Wf	"	6	"	1" x 12" x 12'	Fb, Fd.	" " " " " "
"	Posts	12" x 12" x 24'	P1	"	10	Splices	1" x 12" x 12'	Sa	" " " " " "
"	"	10" x 10" x 40'	P4	"	6	"	3" x 12" x 12'	Sb, Sc	" " " " " "
"	"	10" x 10" x 13'6"	P5	"	2	Fillers	2" x 12" x 12'	Ff.	"
7	Knees	4" x 10" x 10'	P6	Cut to lengths at job "	60	Wedges	6" x 10" x 12		Oak
2	Plates (caps)	12" x 12" x 20'	P2	"	14	Piles	24'		"
2	"	12" x 12" x 16'	P10	"		Lagging	3"x6" 10,000 B.M.		In 12' & 16' length "
2	"	12" x 12" x 16'	P3	"					

BOLT LIST

REQUIRED	SIZE (UNDERHEAD)	REMARKS	REQUIRED	SIZE (UNDERHEAD)	REMARKS
28	¾" x 31" long	At heel of truss (Bev. Wash.	16	¾" x 9" long	For Bracing
28	" x 26" "	"	308	" x 16"	"
28	" x 21" "	"	136	" x 19"	"
140	" x 15" "	For truss members etc.	20	" x 15"	For P2-P3-P8-P10
546	" x 17" "	"	8	" x 13"	For P7-P9
112	" x 19" "	"	28	Dock spikes ⅜" x 20"	
280	" x 25" "	"	14	" " ⅜" x 18"	
70	" x 19" "	For P5 (Knees)			

Timber and Bolt List for Forms for One Complete Span.



Arch Centering for 90 ft. 9 in. Arch at Center Pier.

of the bridge was a well graded bar sand dredged from the Delaware river near Burlington, N. J. That used for the New Jersey side was a bank sand from Birmingham, N. J. Freight rates governed the contractors in using the two different sands.

The following tables herewith show analyses of the sands:

Tensile Strength
⅓ Mortar

	Ottowa Sand 7 days (Lbs.)	Sample 7 days (Lbs.)	Per Cent Ottowa Sand 7 days	Voids	Weight Per cu.ft (Lbs.)	Per Cent Silt
Delaware river bar	399	279	70	44	94 11/16	1.5
Birmingham bank	419	310	74	40.1	92 8/16	2.8

Granulometric Analyses.
Per cent Passing Sieves Retained on

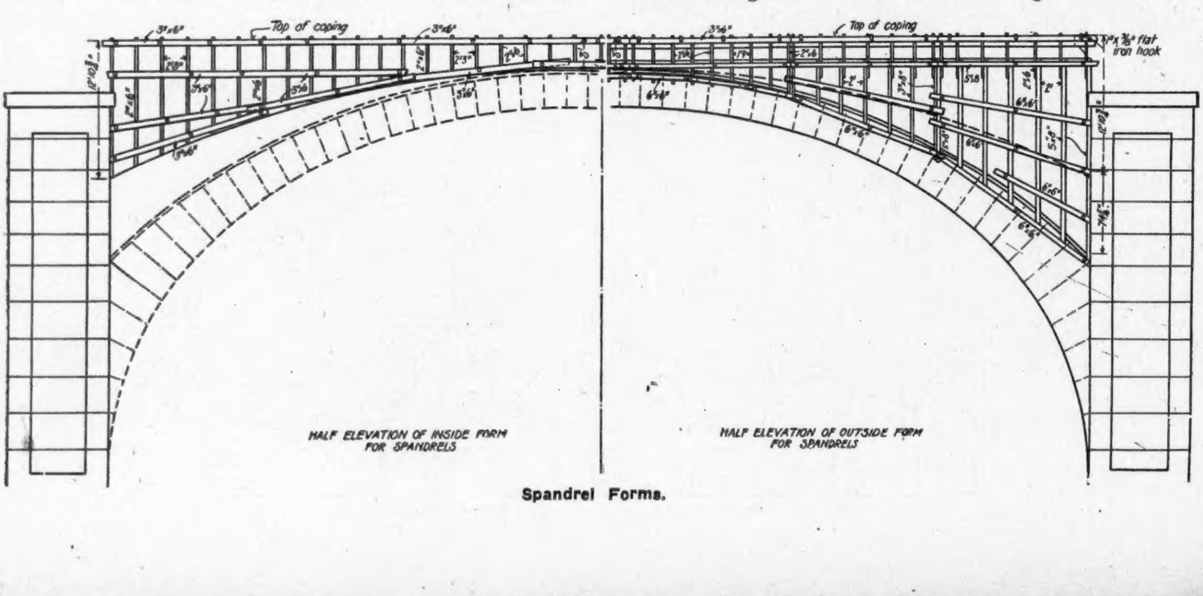
	No. 200	No. 100	No. 80	No. 50	No. 40	No. 30	No. 20	No. 10	No. 10
Delaware river bar	0.9	1.3	1.4	21.8	18.1	23.5	16.7	16.3	19.9
Birmingham bank	1.4	8.9	9.2	23.8	10.5	12.5	15.7	18.0	0.5

While the specifications called for crushed stone to be used in all concrete, the contractors were allowed to use river pebbles for the Pennsylvania side of the structure. These were well graded in size from ¼ to 1¼ in. Crushed stone was used for the New Jersey side ranging in size from 1¼ in. to a small percentage of dust, being the run of the crusher.

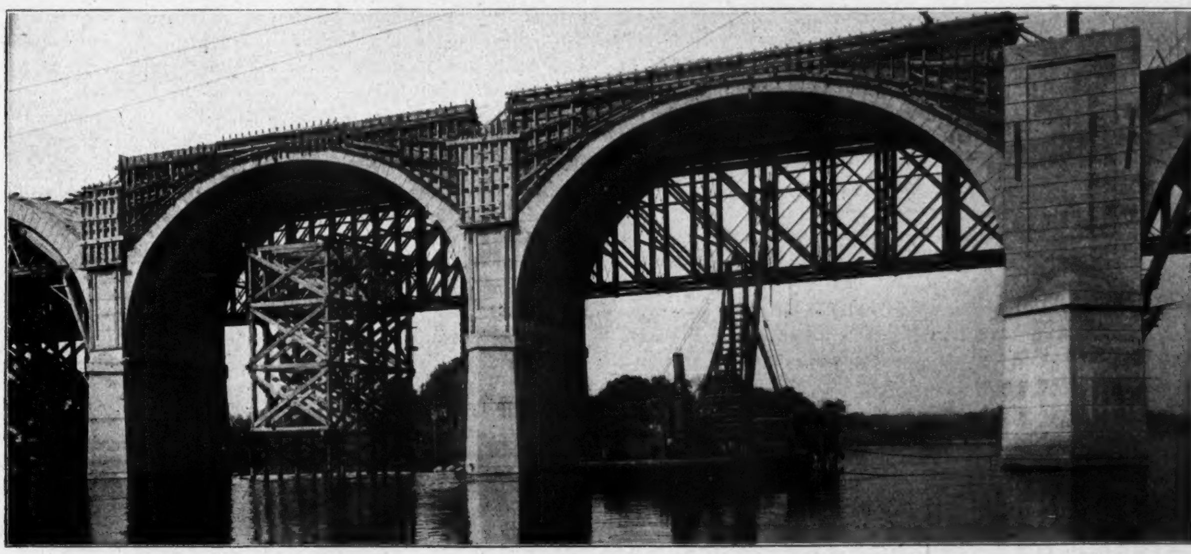
Concrete Surface and Construction.—In constructing the piers and the umbrella sections, the work was so arranged as always to stop the day's work at the inner edge of a triangular wooden fillet or scoring, 1½ in. wide, in order to hide as much as possible any irregularity on the surface. The sections between scorcings were so designed as not to be more than the day's capacity of the mixing plant and also with a view to avoiding night work.

On the face of the pilasters and umbrella sections, the scoring was closer together than on the piers, and coincided with the scoring of the arch rings. There were 18 of these in the umbrella section. The arch ring between the umbrella sections was divided into 35 voussoirs by the scoring. Fillets were used at the showing corners of all contraction joints, and on all salient corners.

The showing face of the concrete throughout the struc-



Spandrel Forms.



Spandrel Wall Forms in Place. Note Detail of Center Pier Pilaster.

ture, with the exception of the railing posts, was spaded. The latter were bush-hammered. The spading against the metal lining of the forms produced a very smooth and uniform surface. The specifications called for a granolithic finish throughout, to be scrubbed and washed, exposing the grit, or bush-hammered if the contractor so desired. The change in the specifications to a spaded face was granted at the solicitation of the contractor, who agreed to give a finish equal to the granolithic finish, in appearance and uniformity of color and surface.

In building the umbrella portions, they were carried up in sections corresponding to one or more of the face scorings. The arch ring was divided into six large sections or voussoirs, three on either side of the key; the key section was about 2 ft. wide. Two opposite sections amounted in contents to about 10 hours' run of the mixing plant. Corresponding with the joints between the ring sections were vertical joints through the spandrel walls and extending through the coping, providing weak joints in case of any tendency to open up on account of shrinkage or temperature changes. Tongued and grooved joints were used in every case. In order to prevent the bending of one section with the other and to form a cushion between them, corrugated asbestos boards were placed on the faces of the joints. In the joint at the junction of the spandrels and pilasters, a double thickness of boards was used.

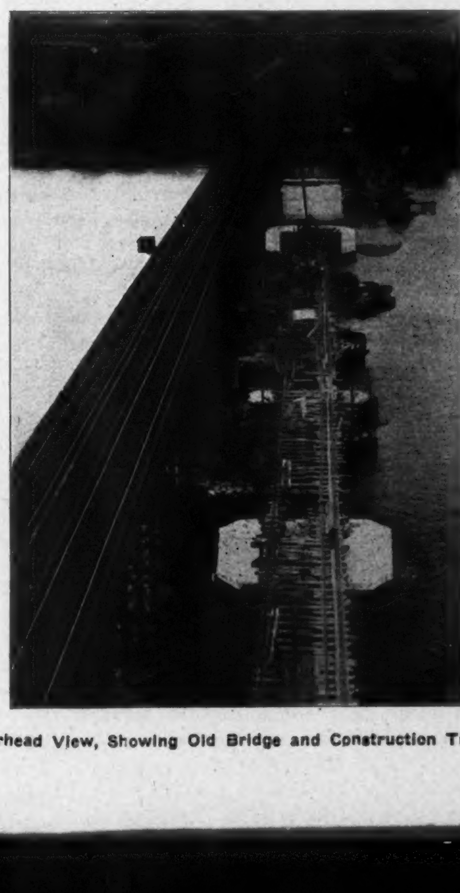
As the main centers were designed for a loading equivalent to the thickness of the showing ring, the entire ring for this thickness was first completed and keyed up, after which the haunching was placed. The haunching was kept back 2½ ft. from the showing face, thus bringing the extrados joint between the spandrels and arch ring at the top of the projection of the rings.

The skewback for the main arch ring was formed by the radial line passing through a point on the intrados, 15 ft. (measured horizontally) from the center of the piers. The portion of the arch below this skewback—called the umbrella—was constructed as part of the pier.

The sections of the ring were built in pairs, one on each side of the crown, in order to balance the horizontal thrust on the centers. These were constructed continuously from start to finish, so as to avoid any intermediate joints. Fortunately nothing occurred to prevent the carrying out of this method.

The turning of the arches began with the arch adjacent to the center pier, after the centers for four arches had been placed in position. The first two voussoirs cast were those at the crown of Arch No. 7. The next pair placed was at the crown of Arch No. 6. This was done to weight down the centers at the middle and also to obtain the maximum settlement in the centers at this time. In Arch No. 6 it was done to add weight to its center that it might better take any horizontal thrust while the sections at the skewback of No. 7 were being placed.

This rotation was carried through the construction of all the rings. The haunching was not placed until the key section had received a hard set. The centering was required



Overhead View, Showing Old Bridge and Construction Trestle.

to be maintained under the completed arch ring for at least 30 days.

In framing the centers they were given an additional height at the crown of about 1¾ in. above the plan height to allow for any compression in the centers and in anticipation of some settlement after they were struck.

Levels were taken on the centers before and after completing the crown sections; on completion of the haunch blocks; on completion of the key; and before and after striking the center. The greatest deflection was at the time of completing the crown sections, which ran from 05/100 to 13/100 of a ft.

In the first centers that were built, an attempt was made to obtain the additional height at the crown by manipulating the wedges, but this proved unsatisfactory. The remaining centers were then framed so as to give the required 1¾ in. additional height at the crown.

Most of the arches deflected so as to be about ¼ in. below the plan elevation at crown after striking centers, and four were ¼ in. higher.

At the present writing the centers under arches Nos. 1 and 14 have not been struck on account of the cable-way towers interfering with their completion. These towers are now being dismantled.

The spandrel walls were completed after the centers were dropped. On account of the liability of a side movement in the spandrel walls during construction, the coping was not constructed until after the spandrels for each arch had been entirely completed and the concrete had received a set. The posts for the railing were all cast in place.

The total quantity of concrete of all kinds in the bridge is 84,670 cubic yards, made up of the following materials, viz.:

Cement	42,363	Barrels
Crushed stone and pebbles	37,172	Tons
Sand	21,954	Tons
Imbedded stone	2,558	Tons
Steel reinforcement	262.5	Tons

The total area of surface to be waterproofed will amount to about 42,000 sq. ft. and the stone spandrel filling will amount to about 7,500 tons.

There were used for construction purposes about 1,400,000 ft. B. M. of lumber, 800,000 ft. of which were required for the centering of the arches.

The construction work was carried on under the direction of the Philadelphia & Reading Ry. engineering department, Mr. William Hunter chief engineer.

(A supplementary article describing the entire design and details will be published in a later issue.)

FLASHLIGHT SIGNALS IN SWEDEN.

Thomas Reece.

The Swedish State Railways have, as a result of extended trials, decided to adopt flashlights in their signaling system. A complete trial installation of the A. G. A. flashlight system was put into service on Liljeholmen station on the southern main line of the Swedish State Railway at the end of last year. It was installed on two distant signals, two home signals and both starting signals for main-line trains. The home signals have several arms to indicate the different train routes, as in the German signaling system. Flashlights were fitted to the top lamp governing the main line, but the lower lamps were lighted with steady lights.

It is stated that this installation, which has been subjected to quite varying and unfavorable conditions of weather, has worked satisfactorily. In consequence the Swedish State Railway authorities have now decided to adopt flashlight for two new types of signals, which have been designed by E. G. Windahl, signal engineer of the railways. The whole line between Stockholm central station and Saltskog will very shortly be equipped with them. Fourteen home signals will be provided with a "through passage signal," which consists of an arm mounted below the other arms, about 15 ft. from the ground. When this arm is in the horizontal position (at night showing an orange flashlight) the signal indicates that the train must stop at the platform. When inclined 45 deg. upwards (at night showing a green flashlight), the signal indicates that the train may pass the station without stopping. On thirteen distant signals, which are of the ordinary disc type, an alteration will be made, so that the signal can give three different indications, viz., "caution" (the home signal indicates "stop"), "full speed" (the home signal indicates "clear" for the main line) and "reduced speed" (the home signal indicates "clear" for diverging line). The alteration to the disc signals is to furnish them with an arm, which normally lies upwards along the post, but which is inclined 45 deg. from the post when the home signal shows "clear" for diverging line. At night these new types of distant signals show at "caution," one orange flashlight; at "Full Speed," one green flashlight, and at "Reduced Speed," one green flashlight at the top and one green steady light below and a little to the right. The lamp with this steady light is also lighted with gas from the main piping to the flashing apparatus, and burns normally, when the light is screened, only with a small pilot flame. When the arm is put in the inclined position a valve, opening the main supply is actuated, whereby the full flame is produced. On nine distant signals for such stations where no facing points are situated, and therefore the indication "reduced-speed" signal for diverging line is not required, the ordinary type of disc signals is equipped with a flashlight, which at "caution" shows an orange flashlight. These installations will probably be put into service early in the spring of next year.

IT CAN BE DONE.

Somebody said that it couldn't be done,
  But he, with a chuckle, replied
That "maybe it couldn't," but he would be one
  Who wouldn't say so till he'd tried.
So he buckled right in, with the trace of a grin
  On his face. If he worried, he hid it.
He started to sing as he tackled the thing
  That couldn't be done, and he did it.

Somebody scoffed: "Oh, you'll never do that;
  At least no one ever has done it."
But he took off his coat and he took off his hat,
  And the first thing we knew he'd begun it;
With the lift of his chin, and a bit of a grin,
  Without any doubting or quiddit;
He started to sing as he tackled the thing
  That couldn't be done, and he did it.

There are thousands to tell you it can not be done,
  There are thousands to prophesy failure;
There are thousands to point out to you, one by one,
  The dangers that wait to assail you;
But just buckle in with a bit of a grin,
  Then take off your coat and go to it;
Just start in to sing as you tackle the thing
  That "can not be done," and you'll do it.

—Unidentified.

According to a press report recent rail orders include 6,000 tons for the Minneapolis, St. Paul & Sault Ste. Marie, 9,000 tons for the Chicago & Eastern Illinois, 7,000 tons for the Chicago, St. Paul, Minneapolis & Omaha, 500 tons for the Chicago, Burlington & Quincy and 10,000 tons additional for the Great Northern.

TIE TREATING PLANT AT MACON, CENTRAL OF GEORGIA RY.

During the early part of December, 1912, the Central of Georgia started to operate its new wood preserving plant at Macon, Ga. Before the construction of this plant the officers of the road made extensive investigations throughout the country as to the best manner in which to preserve their ties and, since from 50 to 60 per cent of the ties they were using were oak and cypress, and the rest inferior long leaf yellow pine, they decided to treat the pine ties with the empty cell creosote process, the oak ties with zinc chloride, and all piling, bridge and trestle timbers with the full cell creosote process.

It was decided to locate the plant at Macon, Ga., which is near the center of the system and makes a very good receiving and distributing center. It is just outside the city on the main line to Atlanta, where the company owned about 80 acres of available property, high and dry, with good drainage. The creosote storage tanks were located at Savannah, so that the tank steamers from Europe, which bring in the principal supply for this plant, could discharge directly into the storage tanks. A total storage capacity of 1,000,000 gal. is provided in two tanks.

General View of Macon Tie Treating Plant, Retort Building Incompleted.

The present yard consists of seven tracks. The main ladder is laid with 70-lb. and the storage tracks with 56 lb. steel. The plant is located at the opposite end of the yard from the main line connection, and the loading platform is between the ladder and the cylinder building.

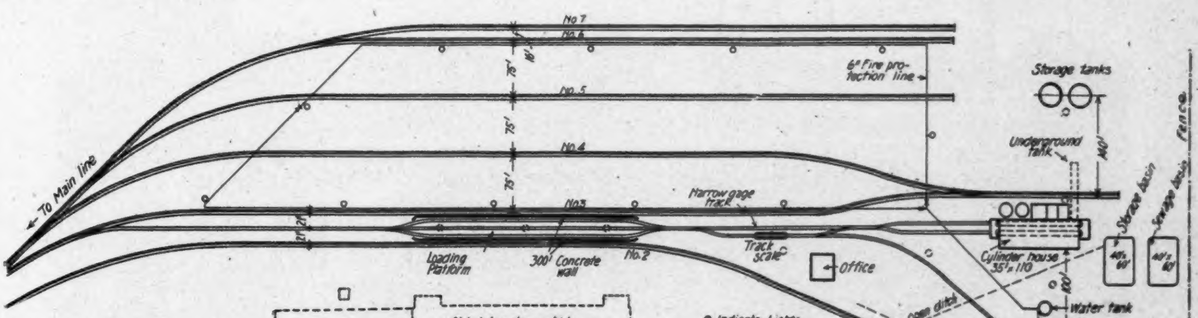
The boiler house and storage tanks are located 100 ft. and 140 ft., respectively from the cylinder house, in opposite directions in order to reduce the fire risk. A 6-in. fire line is also provided around the storage yard, which is connected to a 1,000 gal. fire pump and a 50-ft. tank having a capacity of 50,000 gal. All buildings have steel frames and are covered with corrugated metal sheathing, giving fireproof construction.

The loading platform is located about half way between the cylinder house and the ladder tracks. It is 300 ft. long, with three-rail tracks on each side which are 42 ft. center to center. This platform is 4 ft. high with walls of reinforced concrete retaining an earth fill. On this fill are laid three 36-in. gage tracks. Between the cylinder house and the loading platform there is located a track scale in order to check the absorption, the scale having 50 tons capacity with registering beam for recording exact weights.

The creosote is transported to the plant from the storage tanks at Savannah in 10,000-gal. tank cars, which are set in on track No. 3, over a cylindrical underground tank. When the creosote has been heated to the proper temperature, the bottom connection of the tank car is opened and the creosote drops by gravity into the underground tank in a few minutes. Two general service pumps located in a pit at one end of this tank pump the creosote to the two storage tanks, and from them to the working tanks as it is needed. This arrangement has proved to be economical for handling hot creosote with the least trouble. The storage tanks have a capacity of 150,000 gal. each, and the working tanks 44,000 gal. each.

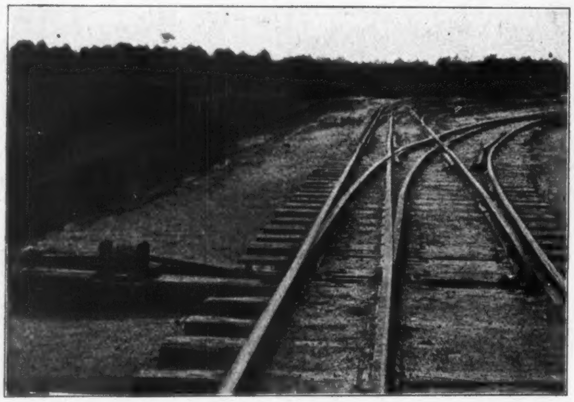
Fused zinc chloride in drums is delivered in box cars which are also set on track No. 3. The drums are stored in the zinc chloride room, where they are emptied directly into a concrete mixing sump near the underground tank from which the chemical is syphoned into No. 1 overhead tank as needed in the treatment.

The cylinders are double end 7 ft. in diameter by 116 ft. long, made of ¾ in. flanged steel plate and designed for a

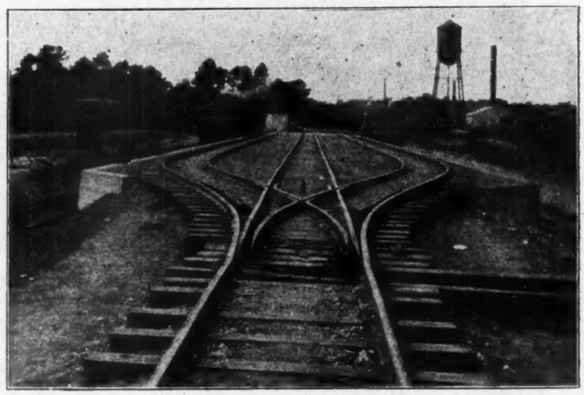


Plan Showing Yard Layout.

Retorts and Storage Tanks. Steel Framework of Retort Building.

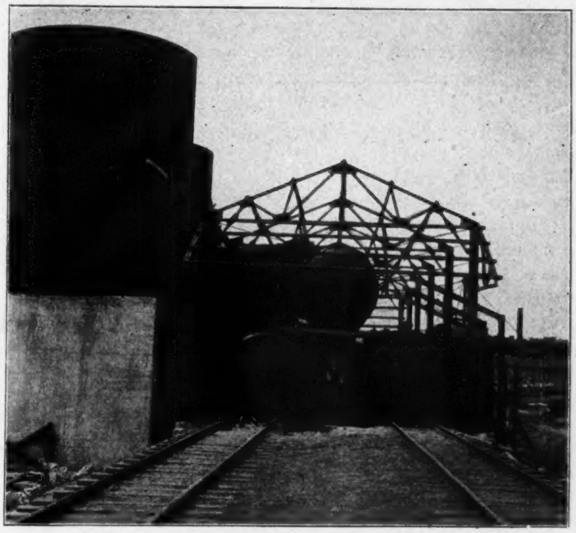


Three-rail Ladder Track.



Elevated Loading Platform.

Foundations of Retorts and Storage Tanks.



Entrance to Retorts.

working pressure of 200 lb. per sq. in. The cylinders are set up on concrete foundations so arranged that a man can walk under them. The cylinders have combination pressed steel and cast steel doors on each end, which are strong, light and easy to handle. Just above the two working cylinders is located an air and creosote reservoir or Rueping cylinder and on the inside of the building, adjacent to the cylinders, are two 7,000 gal. measuring tanks which are direct connected to the pressure pumps, cylinders, and outside measuring tanks. The two working tanks just outside of the building, are set up on reinforced concrete piers, and these tanks are so arranged that the Rueping cylinder, as well as the measuring tanks in the building, can be filled by gravity.

The piping is so arranged that the zinc chloride treatment can be carried on in either cylinder while the Rueping or full cell process is being carried on in the other. For maintaining the pressure on the cylinders there are two pot valve pressure pumps designed for a working pressure of 300 lbs. per sq. in. A Deane vertical uniplex vacuum pump is used to create a vacuum in the cylinder, and an Imperial type air compressor having a capacity of 650 cu. ft. of free air per minute furnishes compressed air to operate the Rueping process and blow back the creosote to the working tanks. One end of the cylinder house is partitioned off to form a shop and generator room which contains a 10 k. w. generator and switchboard furnishing light to the plant and yard.

The boiler house contains two 150 h. p. Scotch marine internal furnace boilers, having a working pressure of 130 lb. per sq. in. In this boiler house there is also located the fire pump mentioned above, a boiler feed pump, and a Hoppes feed water heater. The steam line from the boiler house to the cylinder house and the return exhaust line are carried in overhead steam pipes, making a very neat arrangement.

A Porter locomotive weighing 47,000 lbs. is used for handling the narrow gage tram and bolster cars as well as the standard gage cars in the yard. The locomotive is of 36 in. gage with special cast steel bumpers on each end.

C. K. Lawrence, chief engineer, and J. B. Maddock, engineer of bridges and buildings of the Central of Georgia, had supervision over the building of this plant, and Grant B. Shipley, Pittsburgh, Pa., was the consulting engineer.

We are indebted to C. K. Lawrence and J. B. Shipley for the information and illustrations given herein.

The Atlanta, Birmingham & Atlantic is reported to be contemplating the purchase of 5 locomotives.

CORROSION OF IRON.

Bulletin No. 30, by Allerton S. Cushman, assistant director, Office of Public Roads, U. S. Department of Agriculture, discusses several theories of the cause of corrosion. The Carbonic Acid theory presumes that without the action of carbonic or some other acid, corrosion cannot take place. A second theory presumes that hydrogen peroxide is necessary to cause rust. A third theory is the electrolytic theory, which presumes that all reactions which take place in a moist way are attended with certain adjustments of the electrical conditions of the reacting ions.

The results of this investigation seem to show quite conclusively that rusting of iron is primarily due not to attack by oxygen but to attack by hydrogen ions, supporting the electrolytic theory.

All substances in solution which contain hydrogen ions stimulate corrosive action. Alkalis to a certain extent retard corrosion, and if the concentration is high enough, absolutely prevent it. Potassium bichromate has the latter property in a marked degree. Chromated specimens will stand immersions for days or even weeks before corrosion appears.

It is by no means invariably the case that charcoal iron and wrought iron are more resistant to corrosion than steel manufactured by the Bessemer or Open Hearth process, although there is a widespread impression that this is true. In order to have the greatest resistance to corrosion a metal must be (1) as free as possible from certain impurities such as manganese, (2) or so homogeneous as not to retain localized positive and negative modes for a long time without change. Under the first conditions the irons would seem to have the advantage, but under the second the relative corrosion of iron and steel would depend on the care exercised in manufacture.

The results attained justify the following conclusions: the corrosion of iron or steel is caused by the attack of hydrogen, or through electrolysis; chemically pure iron will not corrode as fast as inferior, poorly segregated metal; homogeneous, well segregated metal is not attacked rapidly by corrosion.

Two methods are suggested for decreasing rapid corrosion; one is by manufacturing better metal, the other by the use of inhibitive coatings. It appears that chromic acid and its salts should come into use under certain circumstances to retard extremely rapid corrosion by electrolysis.

Manning, Maxwell & Moore, of New York City, have taken on the agency for the Chain Belt mixer, concrete elevator spouts, and other concrete machinery manufactured by the Chain Belt Co., Milwaukee, Wis.

The Virginia, it is stated, is considering plans to build a line from Rich Creek, Va., to Hinton, W. Va., where connection would be made with the Chesapeake & Ohio.

The Raymond Concrete Pile Co. of New York has been awarded a contract for placing 2,047 standard Raymond concrete piles for the foundation of the new Rock Island elevator at Kansas City, Kansas.

The Weir Frog Co. has recently abandoned the use of its horses for hauling. In the future it will do all of its hauling with 4-ton gasoline trucks.

The Pennsylvania has ordered 1,000 refrigerator cars, and 500 steel and wood gondola cars from the American Car & Foundry Co. This road has also ordered 805 steel and wood gondolas from the Standard Steel Car Co. It is also reported that the Pennsylvania will soon be in the market for about 250 passenger cars.

The Rutland has ordered 3 smoking cars, 2 coaches, 2 baggage cars and 1 mail and baggage car from the Osgood-Bradley Car Co. The Rutland is also in the market for 25 refrigerator cars.

RAIL CREEPING.

By J. G. Van Zandt, C. E.

Among the peculiar phenomena of the maintenance of railway track, one of the most interesting (and sometimes most perplexing and troublesome) is the continual movement of the rails along the ties. It has long been observed by trackmen and engineers and many interesting accounts have been published in regard to this movement with theories accounting for the action.

"Rail creeping" has been found to assume astonishing proportions and to cause a large number of wrecks in some localities. An incident often quoted in this connection is given by Mr. Thomas Keefer of the Canadian Pacific Ry. (Am. Soc. C. E. XIX. 1888) who witnessed a movement of over two feet with the passage of a single train over a "muskeg" or swampy locality. Others have observed creeping with the traffic and down grades and others against traffic and up grades. In many cases it is reported to have moved around sharp curves and to have straightened out on the following tangent or reversed on a following curve.

The results to the track are well known to trackmen who have to continually combat this tendency. "The movement," says Mr. Camp (Am. Soc. C. E. 1904.), "causes trouble and expense in many ways. It shoves joint ties off their tamped beds upon loose ballast; frogs are crowded out of alignment, and wrecks are not infrequent from such causes." Signals and switches are put out of order and splice bars broken so that constant inspection is made necessary to insure safety of operation. The alignment at crossings is often disturbed and many irregularities of track are due to the accumulative creeping of the rails. At summits rails have separated several feet, the bolts shearing off or splice bars breaking and track crowding in the sags where kinking out of alignment frequently occurs.

Numerous appliances known as "anti-creepers" have been devised to prevent this movement, some of them combining the splice bars with the holding device. These generally consist of a plate fastened to the rail and held to the tie so that any movement of the rail will be retarded by the resistance of the tie in the ballast. The result has been unsatisfactory, in many cases, because the ties have moved with the rails and "bunched" before the creepers; however where creeping is not excessive "anti-creepers" have prevented appreciable movement.

For obvious reasons it is not desirable to run the risk of throwing additional stresses into the bridge structures by attempting to hold the creeping rails by "anti-creepers." Hence in many places the rails are left free to move across the bridges. In some localities there is very little trouble from creeping and no provision is made for it. In other places the placing of blocks between ties to reduce the wave-motion of the rail has been used more or less successfully. In some bridges however it has been a difficult problem, especially with long spans giving considerable deflection, and especially where the elasticity of the ties beneath add to this depression by remote support. The Eads Bridge across the Mississippi River at St. Louis, Mo., has an excessively heavy traffic and has the remarkable record of rail creeping, being forty-two (42) feet in a single month.

In this bridge, devices have been made for handling the rail as it moves, switch points being placed where the process begins and ends. At eight points on the bridge these "creepers" are located requiring the services (day and night) of eight men. A full description (Sci. Am. Mar. 24, 1900) of the "Irishman" or rail creeper has been given by the superintendent of the structure, who states that "the creeping occurs not only on the bridge but also on the approach trestles. It is always in the direction of the traffic. The movement is dependent upon the elasticity of the track supports and varies with the tonnage passing over the rails. An attempt was made at one time to check the movement but the strain on the fastenings was sufficient to tear fish-plates in two and shear off seven-eighths inch track bolts." "A further study of this bridge," states Mr. J. B. Johnson (Journal of Ass'n. of Eng. Soc. Vol. IV. Pg. 8, 1885), "reveals the secret of the causes of the phenomena. The tendency is due to the wave motion which is made causing the rail to be longer than the corresponding linear distance. The rail is seen to roll along on its base and move as much as the base is longer than the neutral axis." A careful study of the depressions of the track, due to this rolling load, reveals the following:

(1) There is first a rising of the rail from the tie at a point about ten feet in front of the wheel.

(2) A deep and rapid depression follows as the load approaches, reaching a maximum under the wheel.

(3) Between the wheel loads there is a slight raising of the rail varying with the weights and the distance between them.

(4) The forward motion occurs just in front of each wheel.

Figure 1 is a diagram showing the motion as theoretically determined by Mr. Johnson. The load advances from P to p and the base is held down by the weight upon the rail so there can be no movement backward. The frictional hold would probably be thirty per cent or more of the weight upon the tie, not to mention the grip of the spikes, etc. It is obvious that while depressed under a wheel load the base of the rail is on the circumference of an arc of greater radius than the neutral axis. Since the base cannot slip the neutral axis must move forward

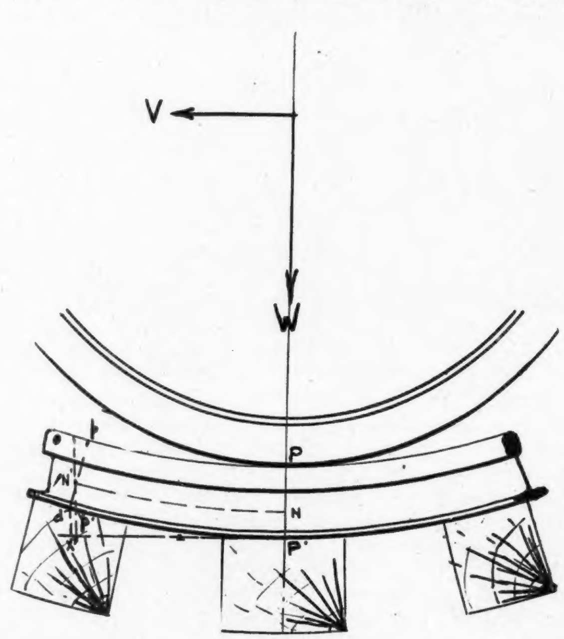


Figure 1.

the difference between lengths of the arcs. As there is a difference between the length of the neutral axis when horizontal and when on the curve, in the rolling of the wheel load there must be an elongation or a movement. If there were no wave motion beneath the train and the depression was uniform, the depressed curved track would evidently be longer than the original horizontal track since the straight line is shorter than a curve. It would appear, therefore, that the advance wave and depression, together with the resilience wave in the rear are the causes of the horizontal motion of the rail.

On the basis of the above theory, it follows that, should the rail be supported in some manner from the top, it would move in the opposite direction. This it has been shown actually to do upon a model constructed for the purpose. This model was prepared with a wooden rail mounted on springs and free to move. A rolling weight was moved around a circular track causing deep depressions. A forward motion was very apparent when the rail was supported at the base and a similar back-

ward motion when the rail was supported from the top. A practical demonstration of this action has also appeared in bridges which show a marked tendency to move on their supports unless held by rigid connections. Through spans are thus forced forward and deck spans backward.

Many contradictions appear among the observations of creeping rails; some observers declare that the outer rail on curves creeps more than the inner, whereas others claim the reverse, and similarly some state that on tangents the right hand rails move more than those on the other side (in the direction of traffic). A typical report of investigation is found in the record of the annual meeting of the Roadmasters' Association of America, 1898, a part of which is quoted below:

"Rails creep in the direction of traffic on double track lines. This creeping is found to be the greatest on down grades and worst where tracks are laid over marshes.

"It has also been ascertained that on curves the outer or higher rails creep the more.

"The cause of creeping track is the rolling load passing over it . . . producing a wave motion.

"It is doubtful if a remedy exists or can be found."

"The most common method is to rely upon anchorage. Three-tie joints give best anchorage but do not prevent creeping."

"The best method is to restrict the wave motion which can only be done by having a rail stiff to transmit weight over greater area of ties and ballast, track to be well tied, and ballast dressed off full at the ends of ties (to prevent skewing of ties and tightening of gage) but to allow for drainage."

Reference is made to the experiments of Mr. Howard on the C. B. & Q. R. R. for the determination of the rail depressions. (Watertown Arsenal Reports 1905.)

A long series of tests were made and the results carefully prepared, showing the actual depressions under different loads with different rails and roadbed conditions. It was found that generally speaking, and other things being equal, of the three kinds of ballast used, viz., stone, gravel and cinders, the gravel ballast gave the least average depressions. The advance wave was well demonstrated and found to be eight to ten feet in front of the locomotive and to rise to a level about one-fourth of one inch above the depressed track under the wheel load. A series of readings were also made with a spirit level to determine the slope of the rail as the loads passed over it. From these it appears that there is a hump in the rail immediately preceding each wheel like that produced by sliding a heavy weight over a carpet. This, of course, is true for moving loads only, and considerable difference will be found if the locomotive were to be let down upon the rail from above by a crane, thus giving static depression curves.

A number of interesting experiments are given by Mr. P. H. Dudley, who invented a micrometer for measuring the strains in rails. (Inst. M. Engrs., Vol. 29, p. 321.) His results are interesting, revealing the stresses due to these depressions and concentrations of weight. He concludes that "heavier rails distribute the weight better," the design being an important element. "The dynamic effects increase with the roughness of the rails and treads" and with the speed, especially on track with many irregularities. New rails do not appear to show a reduction of wave motion, probably on account of their non-conformity to the worn threads of the wheels. It has been observed that "it requires two years and over before heavy rails reach their best condition in the track." The readings of the stresses in the rails indicate that the "strains increased 14.3 per cent with an increase of speed from two to ten miles per hour." Reverse stresses were recorded between wheels, indicating compression on the base of the rail. It appears, therefore, that the resilience of the track-bed tends to bend up the rail as soon as the wheels have passed over. It is noticeable that light passenger locomotives with wheels separated by greater distance give greater wave motion than the heavier freight locomotives with drivers bunched together.

A very interesting series of experiments is recorded by Mr. Wagner (Amer. Soc. C. E., Vol. 53, p. 466, 1904) giving actual observed movements of track covering long periods of time. The results show that,

(1) Of the 32 points measured, 21 showed no difference between the movements of right and left rails; 8 showed more for right and 3 the more for the left.

(2) In seven of twelve observations, the greatest creeping was on down grades; five on level showed no difference.

(3) More creeping was observed to occur on embankments or over swampy ground.

(4) More creeping appears on imperfectly maintained track.

Mr. W. M. Camp ("Notes on Track," p. 584) states that "there are two longitudinal movements on rails; One, a molecular movement of expansion or contraction in the metal, the other a progressive shifting of the rails bodily, commonly known as 'creeping' or running." He states also that "the creeping is most rapid during hot weather," and "it is greater on double than on single track," and further that it is generally in the direction of the traffic. The manner of the creeping and the amount depend upon "(1) the character of the ground or foundation for the track; (2) the direction in which the train loads are the heavier; (3) the proportion of the weight distributed on the two rails; (4) the speed of the trains; and (5) the manner in which the ties are spiked."

The view that "creeping is caused by the push of the rolling friction" is held by Mr. Gustav Lindenthal, who further states that the rolling resistance varies as the square of the velocity

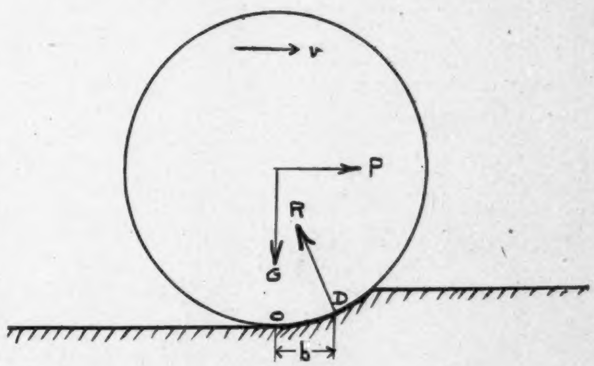


Figure 2.

from 1 per cent at slow velocities, giving a rolling resistance or "rail push" of 50 lbs. for a 10,000 lb. car. At 40 M. P. H. this car would exert a blow on the rail "the same as if a ram weighing one ton would hit the end of the rail with a velocity of nine and one-half feet per second."

The actual value of rolling resistance is difficult to determine as any data is liable to include one of the many other factors which go to make up train resistance.

"That it is a very insignificant part of train resistance" is the contention of Mr. Webb. (Economics of Railway Location, p. 181.) Mr. I. P. Church, in his "Mechanics of Engineering," states that "the word 'friction' is hardly appropriate except when the roadway is perfectly elastic." Referring to Figure 2, he continues: "The track being compressed, its resultant pressure is not at O vertically under the centre, but some small distance O-D in front. The 'rolling-resistance' is therefore

$$R = b \div \text{radius} \times \text{weight}.$$

where 'b' is the small distance O-D."

Mr. Pambour gives as the result of experiment on railroad wheels of cast-iron 39.4 inches in diameter,

$$b = .0196 \text{ to } 0.0216 \text{ inches.}$$

If the force of resistance or the "resultant" can be assumed as acting normal to the track at the centre of the area of contact, we have a triangle of forces one angle of which can be approxi-

mated by the slope tests above mentioned. After working out a series of results in this manner, the values shown in the table below, were obtained.

Similarly with a passenger locomotive and tender it was found that with 70-lb. rail and gravel ballast the rolling resistance of the engine was 2.21 lbs./ton and of the tender 1.59 lbs./ton.

The above analysis demonstrates the fact that the rolling resistance is a small part of the train resistance probably seldom reaching as much as 1 per cent of the weight in any well maintained track. Further, on the basis of the above analysis of rail creeping, the rolling resistance is not all taken up by the rail by "glancing blows" but is communicated to the track below and results in the depression of the earth or "settling" of the track so commonly observed. It is not improbable that a part of this energy is consumed in producing the forward movement of the rail, but this would not be an important factor in its determination. The statement has been made that rolling resistance increases on curves, but evidently resistance other than the "rolling friction" was taken into consideration and it is probable that in a more careful investigation it would not be materially different on curves of ordinary radius than on tangent. In the light of the above it appears improbable "that there would be no creeping with a continuous rail," as Mr. Lindenthal asserts. If the rolling resistance is the controlling factor, there is no reason

TABLE OF ROLLING RESISTANCE OR "RAIL PUSH"

Wheel	Load (Axle)	Slope	Resistance.			Remarks
	Pounds	Per Cent	Pounds	#/Ton	Total Pounds	
Pilot	11,000	0.0241	22.14	4.02		Rail 85 lbs. A.S.C.E.
Driver	26,500	0.0149	32.904	2.48		Stone Ballast
"	27,500	0.0110	25.205	1.84		Oak Ties
"	31,300	0.0065	16.948	1.08		
"	28,500	(-)0.0025	(-) 3.854	0.03	93.343	or 1.51 #/Ton
Tender	15,950	0.0125	20.913	2.52		
"	"	0.0080	10.633	1.33		
"	"	0.0190	25.251	3.17		
"	"	(-)0.0010	12.287	1.66	43.510	or 1.36 #/Ton

Rolling Resistance.

why a continuous rail would remove creeping. The concussive and oscillatory factors would be materially reduced as with any item improving the track condition, but any improvement of the track reduces wave-motion as well and in this way only may reduce creeping.

The prevention of rail creeping has always been a serious problem of track maintenance. Of the many appliances now on the market, few attempt to remove the cause of the greatest part of this movement. To summarize the conclusions of practice, we find the following recommendations:

(1) *Good track.* If alignment, drainage, ballast, tieplates, spiking, is all first class, much of the creeping can be prevented. "Track inspections show that almost invariably the rails on the outside of double track are subject to greater average deflection." (Camp, "Notes on Track," p. 588), and this is due to the lack of ballast on the ends of ties and shows the importance of the suggestions made by the committee of the Roadmaster's Association above quoted.

(2) *The desirability of traffic moving in both directions* over the same track and the equalizing of tonnage in each direction.

(3) Most of all, the necessity of *removing the cause of the wave-motion* by preventing depressions of large amount under wheel loads.

If the other conditions are well taken care of, then the only

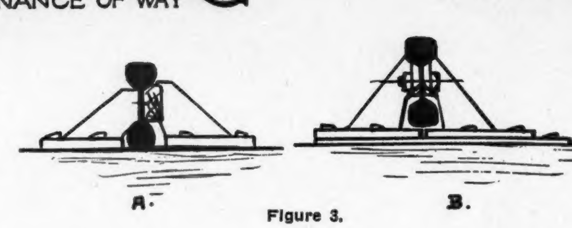


Figure 3.

remaining cause of consequence is the rolling of the rail on its base as above described. It is evident that to overcome this effect, it is necessary to support the rail at such a place above the neutral axis that the tendency to move backward due to wave-motion will counteract the forward tendency due to the difference in length of the curved and the straight rail.

This requires a new rail of such shape and a support of such design as will fulfill the conditions stated. This would also mean a design to meet the special conditions of each locality where great trouble is found with creeping. A rail somewhat approaching this design is found in use in England where creeping is almost unknown. The rails are not supported by the head, but prevented from moving sidewise by supports which are wedged against the web directly under the head and they doubtless transmit some of the concentration to the tie. (See Fig. 3 A.) Some similar system could be used in localities of much creeping and ought to remove the cause of the difficulty. In the figure it is suggested that "B" supports the rail under the head and leaves the base free to move with the inevitable wave motion, but there would be no tendency to move forward. This would require the use of the English rail section, which for many other reasons might be undesirable.

As a practical solution of the problem, on long span bridges such as the Eads bridge above mentioned, the type of construction shown (in Figure 4) is suggested. This might also be found of advantage in other places of excessive rail creeping. Two rails are turned base to base and bolted together with track bolts. The two sections are so selected that the neutral axis lies sufficiently below the point of support to counteract all tendency to move forward. The support is of such design that the weight is well distributed and investigation shows that there would be no danger of deformation or shear with ordinary rails and present loads.

Rolling loads upon passing over this track would produce some wave motion, but that which would be produced, would be taken care of in the backward motion of the head of the under rail. All the causes would therefore be removed and the conditions would be fulfilled to prevent the rail from creeping.

Comparative observations have been made upon bridges which have stringers directly under the rails and those supporting the rails on the ties at some distance—as in the support of double track on three stringers. A very marked increased creeping is noticeable on the design involving the elasticity of the ties.

In conclusion, it appears that by the close study of all the

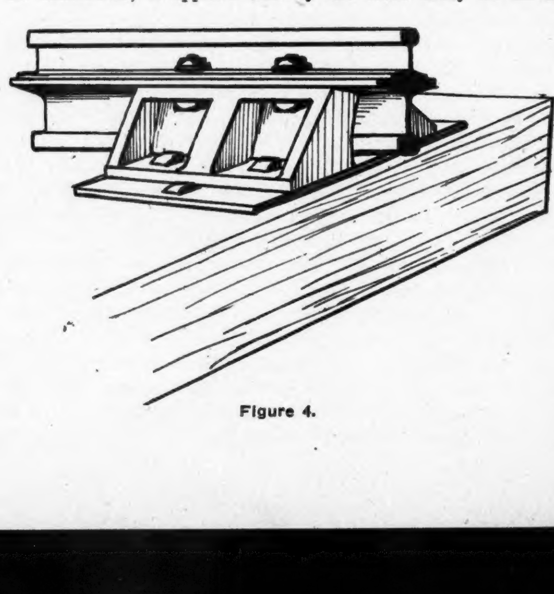


Figure 4.

conditions including the design of the bridge floors and the preparation of the track, practically all the rail movement may be eliminated in a way which when applied to the bridge spans will not bring undesirable stresses into the structure.

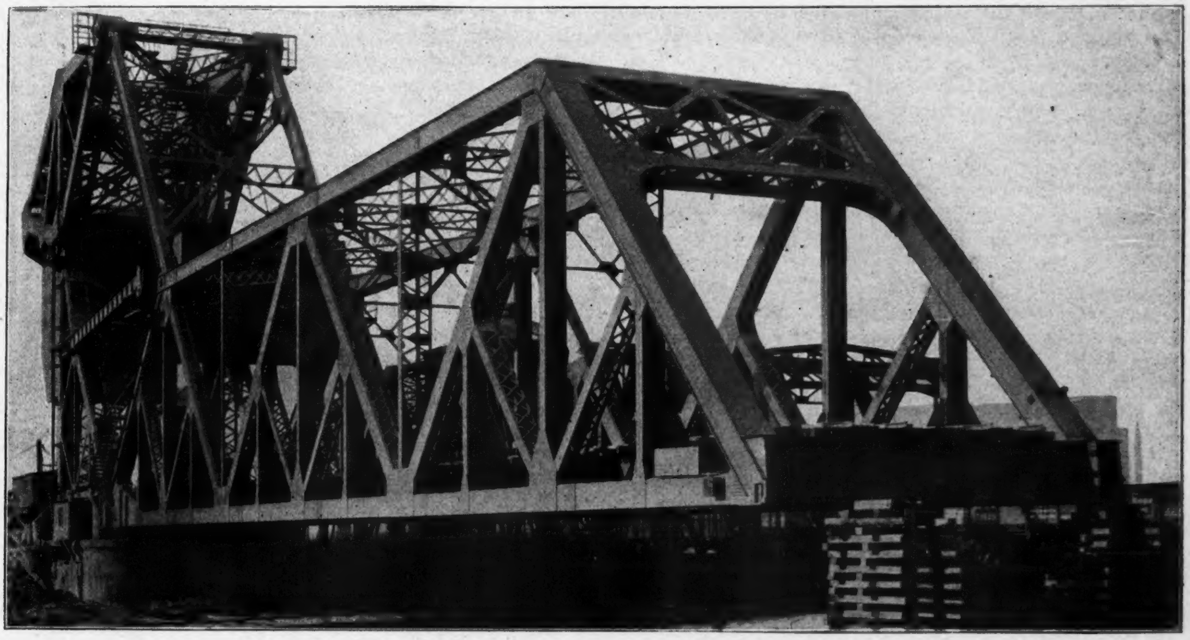
The use of the precautions above noted, together with anti-creepers, on good track on which trains are run in opposite directions with approximately the same tonnage, should completely eliminate the creeping of the rails and its attendant evils. Too much emphasis can not be laid upon the desirability of good drainage for it is necessary that the depression of the rail, under the wheel load, should be a minimum and this requires that the roadbed should be firm and well drained.

CALUMET RIVER BASCULE BRIDGE, B. & O. R. R.

Largest Double-Track, Single-Leaf Bascule Span in the World.

The Baltimore & Ohio R. R. has recently completed the bascule bridge over the Calumet River, at South Chicago, Ill., which carries two tracks and has the unusual clear span of 235 ft., the distance to center of the channel piers supporting the span being 250 ft. This structure replaces a bridge with a swing span and central pier 37 ft. in diameter.

The bridge consists of three spans, two short approach girder spans, and the vertical lift span. The girders are 65 ft. and 50 ft. long. The central span is a Strauss bascule lift. The Strauss mechanism is adapted to practically any type truss or girder. The central span in this bridge being a Petit truss.



Calumet River Lift Span, B. & O. R. R.

The change in the bridge was made to widen the channel and economize in space. The U. S. government recently planned changes in the bulk head line and arranged for greater width of channel. The old bridge gave a clearance of only 80 feet on each side of the center pier; with the new bridge, the width of the channel is practically tripled.

In the immediate vicinity of the new bridge, the Lake Shore & Michigan Southern Ry., and the Pennsylvania Lines West both cross the Calumet River. One of these bridges appears in one of the illustrations produced herewith, and this shows how congested the space is, at this point.

The Baltimore & Ohio R. R. has a right of way 84½ ft. wide on the west side of the river, and 91 ft. wide on the east side of the river.

The new bridge was erected south of the old bridge, and without interfering with traffic. The center line of the old structure was 19½ ft. from the north right of way line, so the construction of the new bridge did not interfere with traffic on the old bridge. The old pivot pier was 37 ft. in diameter. The saving in sub-structure can readily be seen. The center pier, which required a large amount of masonry, because it was circular, was entirely eliminated, and the new foundations consist only of cylinders at each corner, in the

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The Baltimore & Ohio, it is stated, will soon place an order for 60 mikado locomotives, 30 Pacific locomotives and 10 Mallet locomotives.

The Birmingham & Southeastern has ordered one 10-wheel locomotive from the Baldwin Locomotive Works.

The Chesapeake & Ohio is said to be making inquiries for 12 locomotives.

The Chicago & Western Indiana is inquiring for 5 locomotives.

The Grand Trunk is said to have ordered 25 passenger locomotives from the American Locomotive Co., 50 Pacific locomotives from the Baldwin Locomotive Works, 10 Pacific locomotives from the Montreal Locomotive Works and 15 switch locomotives from the Canadian Locomotive Works.

The Louisiana & Arkansas has ordered 4 ten-wheel locomotives from the Baldwin Locomotive Works.

The Maryland Steel Co. has ordered one 6-wheel switcher locomotive from the Baldwin Locomotive Works.

The Norfolk & Western, it is said, is planning to order 60 additional Mallet compound locomotives.

The Pennsylvania is said to have increased its orders with the American Locomotive Co. from 45 to 110 and with the Baldwin Locomotive Works from 15 to 40 locomotives.

The Atlantic Coast Line has ordered 4 six-wheel switching locomotives from the Baldwin Locomotive Works.

The Baltimore & Ohio is said to be considering the purchase of a large number of locomotives.

cases of piers 1, 2, and 3, connected at the top by heavy, reinforced concrete girders.

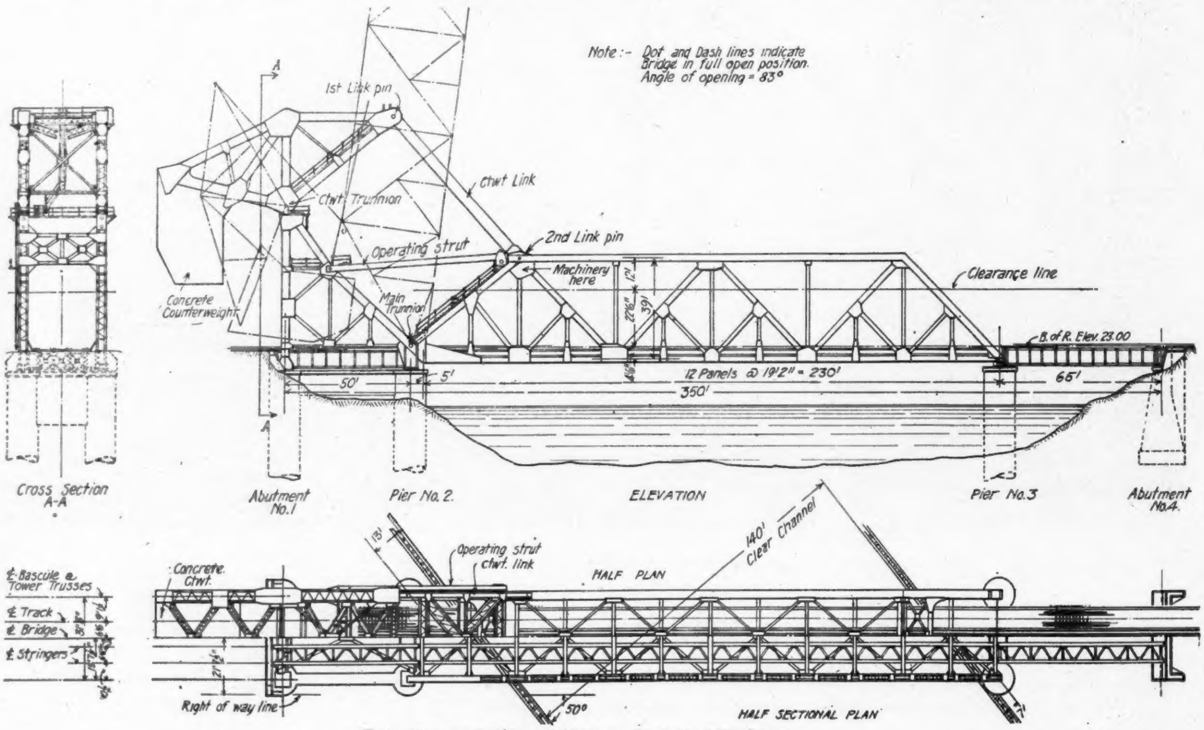
The excavations for these cylinders were carried to solid rock, 65 ft. below the water level, using pneumatic caissons. Pier No. 4 (abutment) rests on a pile foundation, while piers 1, 2, and 3 are founded on solid rock.

Piers 1, 2, and 3 are similar, each having 2 cylinders 12 ft. in diameter, connected at the top with transverse girders. Piers 1 and 2 are also connected to each other by longitudinal girders of reinforced concrete, 13 ft. long. These, with the transverse girders, form a rectangle. There is no load on the longitudinal girders, but they give added rigidity and stability. The mixture used was 1:3:5 concrete with crushed stone; in main body of cylinders; the coping is a 1:2:4 mixture, with 1 in. top layer of 1:2 mortar with trap screenings.

The cylinders are 31 ft. 3 ins. center to center and have the channel. Pier No. 2 is 30 or 40 ft. from the edge of the 22 ft. (deep) channel, while pier No. 3 is located right at the opposite edge of the channel. The river slopes off rapidly on each side, to a practically uniform depth of 22 ft.

The lift span is what is called the heel trunnion type, a general description of which should be of interest, since it has never been covered in detail in these columns, although a standard type of which some 50 or more are in service. There are two fixed trunnions, as shown on the diagram, the main trunnion at the lower extremity of the truss, and the counterweight trunnion, near the center of gravity of the counterweight structure. The center of gravity of the whole structure, the movable leaf and the counterweight, does not move either vertically or horizontally when the span is lifted.

The movable leaf pivots about the main trunnion, and the counterweight pivots about the counterweight trunnion. The



Elevation and Plan of Strauss Bascule Lift Span.

vertical reinforcing rods of 1 in. section, spaced in a circle 4 ins. from the outer surface. In pier No. 2, these rods are spaced on 6 in. centers from elevation —50 to —2, and on 12 in. centers from —2 to top of cylinder. The horizontal reinforcing hoops are ¾-in. bars, and they are spaced on 12-in. centers up to +10, and above that on 6-in. centers. The reinforcing of the other pier is similar.

The transverse girders between piers were cast monolithic with the piers. They are 25 ft. long, 6 ft. deep and 7 ft. wide. The top of each girder is reinforced with 3 tiers of reinforcing bars, 33 bars in all. Below this tier, are rows of horizontal rods spaced 6 in. from the faces of the girder and on 2 ft. centers. The lower portion of the girder has two rows of reinforcing, 7 in each row, 6 ins. and 12 ins. from the bottom.

The longitudinal girders between piers 1 and 2 have reinforcing in top and bottom, but the reinforcing is not heavy as there is no vertical load carried by these members.

Pier 4 is rectangular, and rests on 98 piles on 2½ ft. centers. The footing is 18x35½ ft., and the pier has a battered front and back.

The diagram herewith shows the profile of the bottom of counterweight link is parallel to the line joining the trunnions and these lines form a parallelogram with the inclined end member of the truss and the inclined end member of the movable counterweight structure.

Since the center of gravity does not move either vertically or horizontally during operation, the dead load pier reactions are constant and vertical for all positions of the bridge, which gives economy in design of the pivot pier. The dead load on the rest pier is zero. The dead load reaction on the trunnion pier is the weight of the movable leaf, and the dead load on the counterweight pier is the weight of the counterweight and tower. Thus the weight is distributed over two piers instead of one.

The leaf is operated by means of pinions located in triangular guides at the hip of each truss, which engage with cast racks bolted in the bottom of the operating truss (marked in the diagram) which is a built up member. The pinion and rack are held in mesh by the triangular guide.

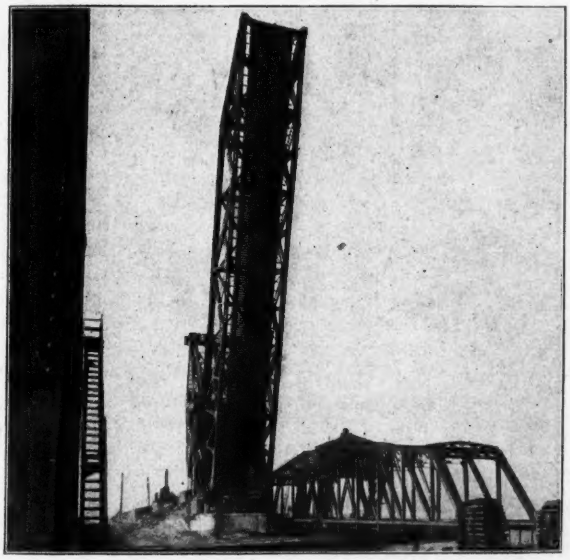
Although there is no tendency for the live load to open the lift span, it is locked when closed. The angle of opening is 83°. When the bridge reaches an angle several degrees less than the total angle of opening, current is cut off from

the operating motors, and a solenoid brake is applied. An emergency brake is also provided, which the operator can apply instantly.

A series of incandescent lights in the operator's tower are provided, the lighting of which indicates the position of the leaf, the idea being similar to that used in interlocking towers where the circuits occupied are shown by a light under a transparent diagram.

An air cushion is located at the center line of the bridge at the end opposite the pivot. This consists of an air cylinder and piston. The piston strikes a plate on the rest pier as the leaf lowers. This cushion is easily adjusted by providing more or less air chamber as required.

The bridge described above was designed by the Strauss Bascule Bridge Co., and constructed by the Pennsylvania Steel Co. under the supervision of J. E. Greiner, consulting engineer of the Baltimore & Ohio R. R., Wm. Bouton, bridge engineer, L. G. Curtis, district engineer.



Strauss Lift Span Open—Calumet River Bridge, B. & O. R. R.

The Atlantic Coast Line has ordered 1,000 box cars and 300 flat cars from the Barney & Smith Car Co.

The Atlantic Coast Line is said to have ordered 100 passenger cars.

The Berwind-White Coal Mining Co., New York, has ordered 100 gondola cars from the Cambria Steel Co.

The Canadian Northern has ordered five dining cars from the Barney & Smith Car Co.

The Chilean State Railways is reported to have placed an order for 17 sleeping cars and 125 coaches with the American Car & Foundry Co.

The Harriman Lines have ordered 1,000 box cars, 800 automobile box cars, and 110 caboose cars, from the Standard Steel Car Co., divided as follows: 500 box cars for the Southern Pacific, 500 box cars for the Galveston, Harrisburg & San Antonio, 400 automobile box cars for the Union Pacific, 150 automobile box cars for the Central Pacific, 30 caboose cars for the Oregon Short Line, 10 caboose cars for the Oregon-Washington, five caboose cars for the Central Pacific, 10 caboose cars for the Southern Pacific, 25 caboose cars for the Union Pacific, and 30 caboose cars for the Sunset Central Lines.

The Toledo, St. Louis & Western will shortly be in the market for 1,000 steel underframe box cars of 80,000 lbs. capacity.

CENTRALIA TERMINAL, I. C. R. R.

The Illinois Central R. R. is just completing at Centralia, Ill., a modern and up-to-date terminal, one which will result in much greater efficiency in handling freight bound for Chicago and points north and west. Centralia is about 250 miles south of Chicago, on the main line of the Illinois Central to Memphis and New Orleans. At this point a division branches off the main line and continues up through the center of Illinois to Freeport, where it joins the line running west from Chicago to Omaha.

All the business from New Orleans, the Birmingham division, the Kentucky division, together with the heavy coal business of Southern Illinois, arrives at Centralia on its way north. It is therefore an opportune place to classify freight so that it may move forward to its destination in full train lots, requiring no further switching. Thus full trains are made up for the various Chicago yards and also for Freeport, Omaha and other points reached by the branching division. The installation of this terminal will greatly increase the efficiency of the entire system, located, as it is, at a vital point.

The old facilities at this point were inadequate and were incapable of expansion, being hemmed in by Centralia and its northern neighbor, Central City. The new yards* and terminal were located just south of Centralia, covering approximately two hundred and seventy-five acres in the shape of a strip 500 feet wide, in addition to, and on the west side of, the old right of way.

The illustrations showing the layout of the buildings do not include the entire yard system. Work on the new terminal buildings was started last year. Following is a list of the buildings which have been constructed, with their dimensions:

Power house, 80 ft. by 70 ft.
Roundhouse and erecting shop.
Machine, smith, boiler, tin and pipe shop, 171 ft. by 82 ft.
Open Car Repair Shop, 90 ft. by 500 ft.
Wood Mill.
Office, storehouse and oil building, 31 ft. by 173 ft.
Finished lumber shed, hand and push car locker, lavatory and tool room, 103 ft. by 35 1-2 ft.
Paint storage building 32 ft. by 18 ft.
Car repair and inspector's shanty.
Ice house, 45 ft. by 145 ft.
Roundhouse and R. F. E. office and enginemen's locker room building.
Scale house and office.
Building for material storehouse, division store room, casting and storeroom, air brake and pipe shop, smith shop and car wheel room.
Toilet houses (three).
Coke and coal storage for blacksmith shop.
Storehouse for engineer's tools, oil cans, etc.
Yard master's office.
Assistant yard master's office.
Signal power house, containing two compressors.
Inspector's building and shelter for cinder pit men.
Coaling station.

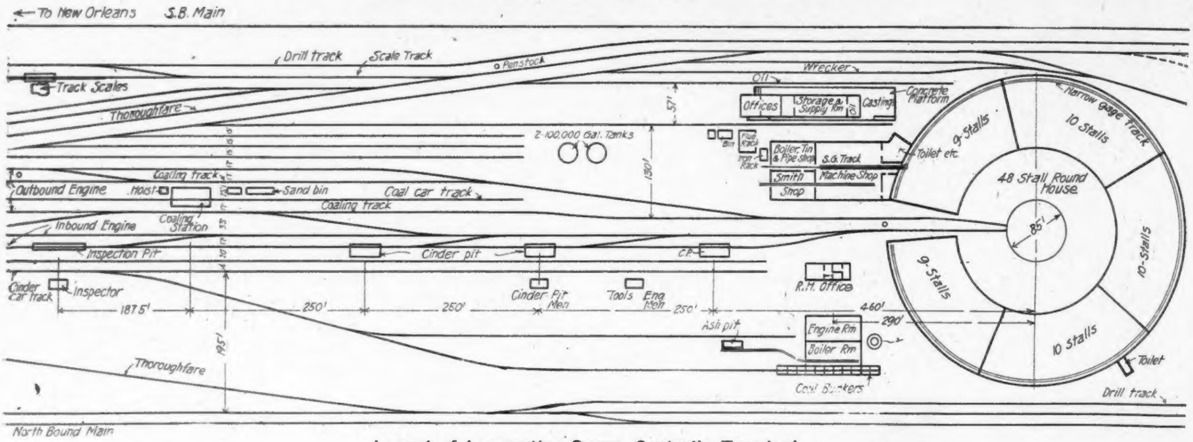
There are also three concrete cinder pits, one 75-foot inspector pit, and two 100,000 gallon tanks.

These buildings are in two groups, the roundhouse and machine shop constituting the nucleus of the southern group and the open car repair shop that of the northern group. The relative location of the buildings in each group is shown in the two drawings, the distance between the two groups being about 2,500 feet.

Locomotive Department Group.

The larger buildings of this group, including the roundhouse, machine shop, office building, storehouse and power house are of brick construction and, with the exception of the round-

*Described on page 360, August issue of *Railway Engineering.*



Layout of Locomotive Group, Centralia Terminal.

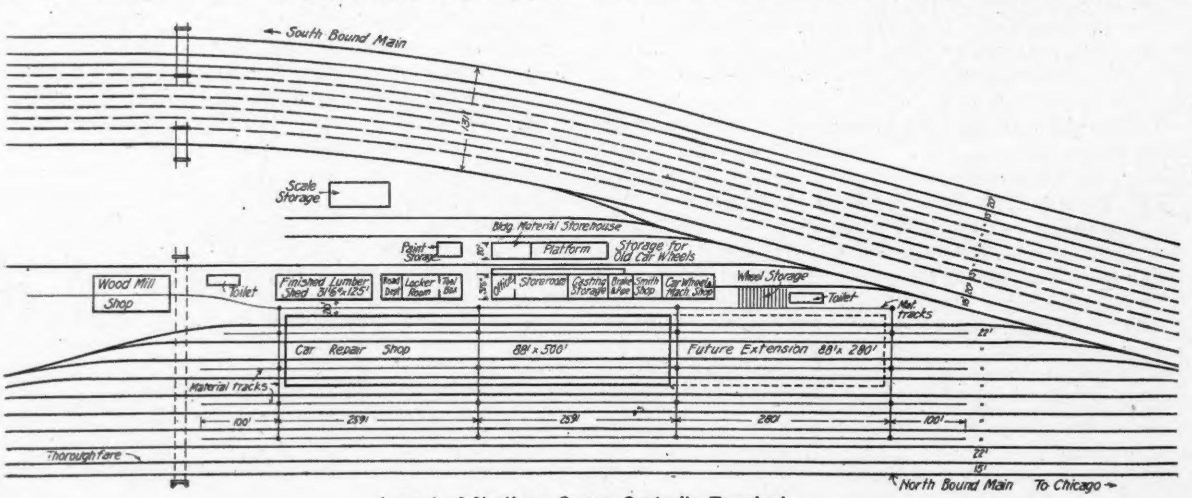
house, have roofs composed of 3-inch reinforced concrete slabs, which is in accordance with recent practice on the Illinois Central. The reinforcing is American Steel & Wire Co.'s No. 4 triangular mesh; the span between trusses is 16 ft. on the machine shop. The roof pitches ⅝ in. in 12 ins. This concrete roofing is covered successively with a coat of hot pitch, a layer of 2 ply tarred felt, another coat of pitch, followed by a second layer of 2 ply tarred felt, and the whole covered with another coat of hot pitch, and covered with gravel. These buildings are all equipped with Fenestra steel window sash, and louvres and windows are operated by the Peerless tension operating device.

The roundhouse consists of 48 one hundred foot stalls and is divided into 5 sections by fire walls, one section of which is used as an erecting shop. This section consisting of nine stalls is of somewhat different construction from the rest of the roundhouse, and has a clere story arranged in such a manner as to secure a maximum amount of light. This section has 7 driver drop pits, 2 truck pits and is equipped with a 7½ ton crane of 52 feet span. This, as well as the cranes used elsewhere, is a Whiting.

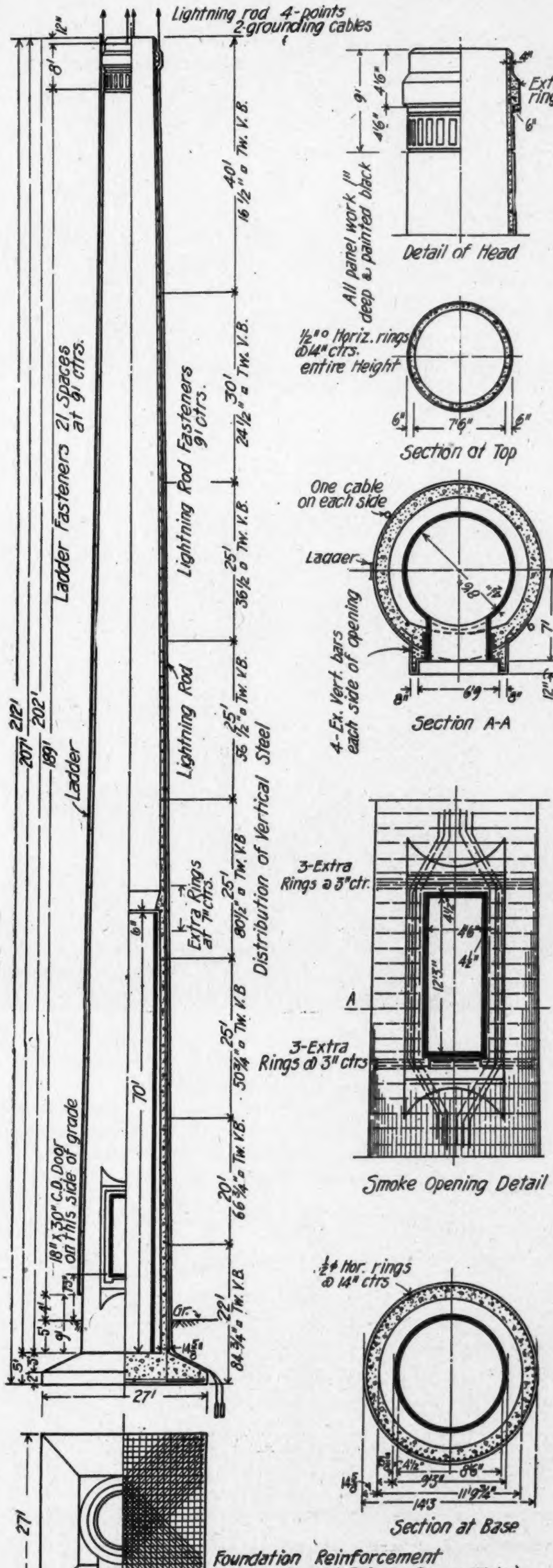
A 24 inch gage material track encircles the roundhouse just inside the outer wall and connects by means of turntable to similar tracks in the machine shop building adjacent. In addition to the customary connections, there is at each pit a box for plugging into a three-phase power circuit, thus enabling the use of portable lathes and other tools. Although the outer wall is of brick, it is constructed in such a manner that an engine going through will only carry out a limited portion of the wall and window framing. This is accomplished by placing in the wall at either side of a panel, two steel columns whose ends are lightly held in place on two flat plates, so that in case an engine goes through the damage does not extend beyond these columns. The openings in the fire walls can be closed by sliding doors equipped with Wilcox hangers. The 85 foot turntable is equipped with a Nichols tractor. Smoke jacks are of cast iron. A 3 inch steam line and a 4 inch air line is run through the house with drops at each post.

The power house is equipped with four 250 H. P. Sterling boilers with provision for the addition of a fifth. The coal bunkers open through the wall. The grates are designed to carry an overload of 25 per cent continuously. A narrow gage track for handling ashes passes in front of the boilers and out to the boiler ash pit. Under this track is a concrete trench for the future installation of a pneumatic ash handling system. The engine room contains two 250 K. V. A. turbo generators with provision for the addition of a third, two 1,000 cubic feet Laidlaw-Dunn-Gordon air compressors, an Allberger fire pump, exciters, and a Westinghouse ten-panel switch board. There is also a Jeansville Iron Works centrifugal pump connected to a Terry turbine, for circulating the hot water for heating the car shop, 2 American vacuum pumps and 2 Blake-Knowles boiler feed pumps. The engine room is equipped with a 5 ton crane and space has been allowed at one end for the installation of a boiler washing system.

The stack is a Weber concrete chimney 204 feet in height, lined for the first 70 feet with radial fire brick lining, built without taper and independent of the chimney with an air space between it and the chimney. This lining extends through the flue



Layout of Northern Group, Centralia Terminal.



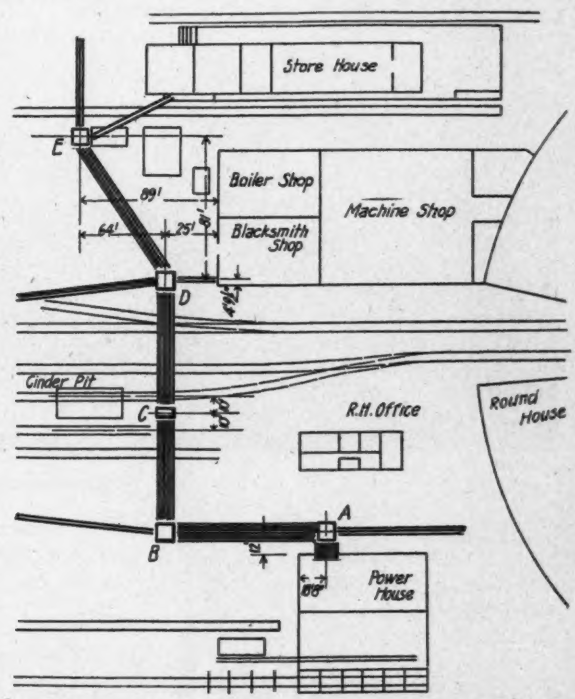
Weber Reinforced Concrete Chimney.

opening and connects with the flue lining, and is guaranteed to withstand 1,500° Fah. A 2 inch pyrometer and a 4 inch draft gage with all necessary connections have been placed in the chimney. The foundation is of concrete, 27 ft. square at the bottom, the lower footing slab being 2 ft. thick. The foundation is sloped off in the next 3 ft. to a square of 14 ft. 2 ins. The foundation is reinforced with a rectangular net of ¾ in. square twisted bars on 12 in. centers, and a diagonal net of ¾ in. square bars on 6 in. centers. The rectangular net is 4 ins. from the bottom of the slab, and the diagonal reinforcing is above this.

The exterior diameter at the base is 14 ft. 3 ins., the chimney wall being 1 ft. 2⅝ ins. thick. The fire lining is 1 ft. 3⅛ ins. inside of the concrete. The exterior diameter at the top is 8 ft. 6 ins., the wall being 6 ins. thick. The horizontal rings are ½ in. round bars spaced on 14 in. centers for the entire chimney height. The vertical reinforcing is as follows:

First 22 ft., 84—¾ in. square twisted bars.
Next 20 ft., 66—¾ in. square twisted bars.
Next 25 ft., 80—½ in. square twisted bars.
Next 25 ft., 56—½ in. square twisted bars.
Next 25 ft., 36—½ in. square twisted bars.
Next 30 ft., 24—½ in. square twisted bars.
Next 40 ft., 16—½ in. square twisted bars.

There are two types of Weber chimneys, the cylindrical type

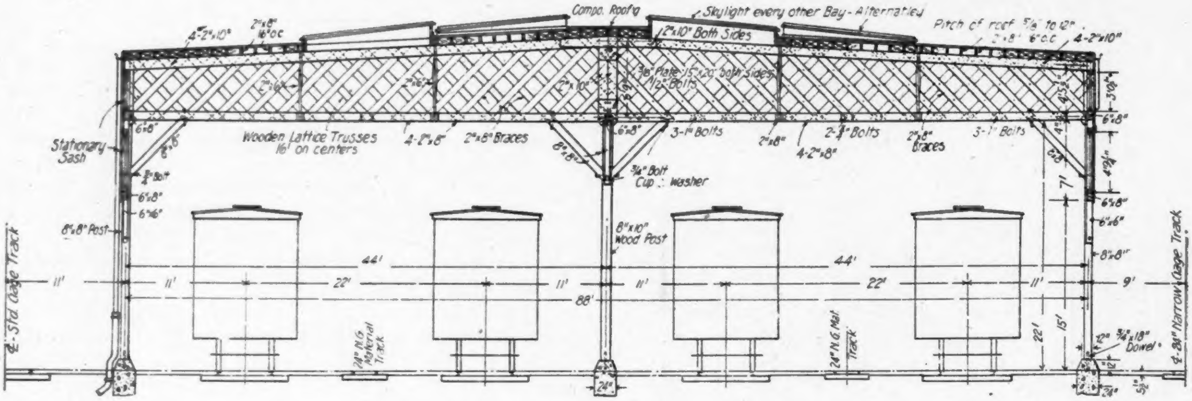


Power Transmission Line Layout.

with vertical walls and equal diameters from bottom to top, and the coniform chimney, with a face batter. The forms for the coniform chimney described herein are of wood in a series of units, and all work is done from the inside of the chimney during construction. The Weber Chimney Co., Chicago, which owns the patents on this type of construction, built the chimney under contract.

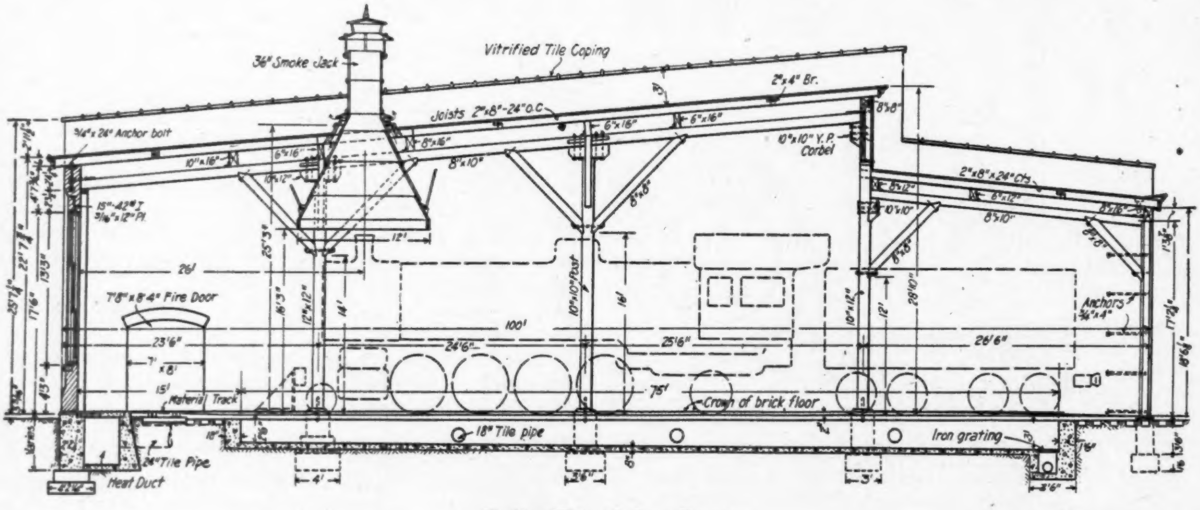
There are to be five steel transmission towers on concrete bases between the power house, machine shop and storehouse. They are of structural steel, and are located as shown in the diagram.

The machine shop building adjoins the erecting shop portion of the roundhouse and contains, besides the machine shop, the boiler, tin and smith shops. Both a standard and a

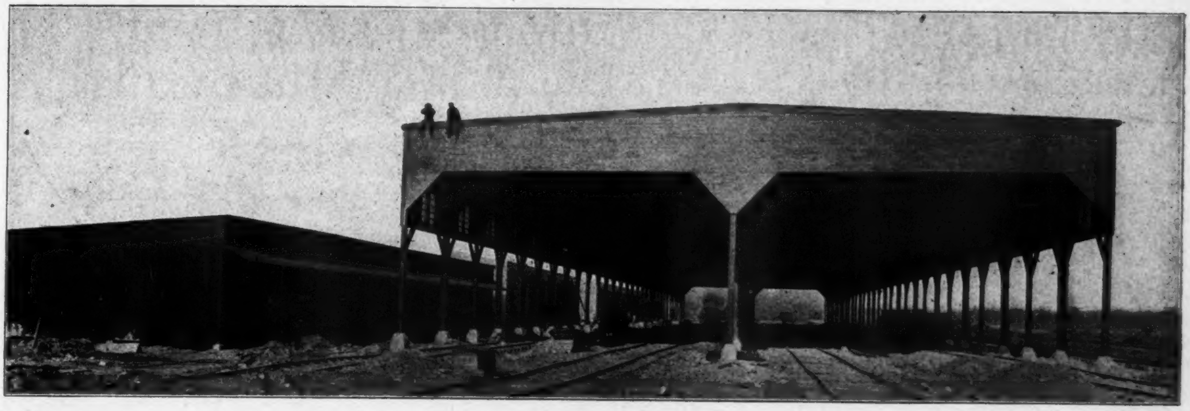


Open Car Repair Shed, Showing Wooden Roof Truss.

Locomotive Group, Centralia Terminal.



Section Through Roundhouse.



Open Car Repair Shed.

narrow gage track enter the machine shop portion, and half of the machine shop is covered by a five-ton, floor-operated crane. The machines under this crane have individual motor drives, those in the other half being driven from a line shaft. The doors connecting the various shops in this building are provided with Kinnear steel rolling shutters, which can be operated from either side, and are connected to the lintel by fusible links. The building is well supplied with skylights and ventilators, and between the shop proper and the roundhouse is a toilet room equipped with 47 steel lockers.

On the first floor of the office and storehouse building are the master mechanic's and storekeeper's offices, together with offices for the clerks. Above this is the record room and the engine men's rest rooms. The remainder of the building is one story and back of the offices is the storage and supply room. At the other end of the building, and separated from the storage room by a brick wall, is the oil and waste room. This room, as well as the storeroom, has a concrete floor, and the roof beams throughout are encased in concrete. In the oil room are 10 Bowser oil pumps of the one-gallon size and three Bowser power pumps. The latter are operated by motor and are for pumping out kerosene, car oil and fuel oil for filling barrels. The oil supply is located in the basement of the oil house. A concrete paltform for storing castings surrounds a portion of the storehouse building.

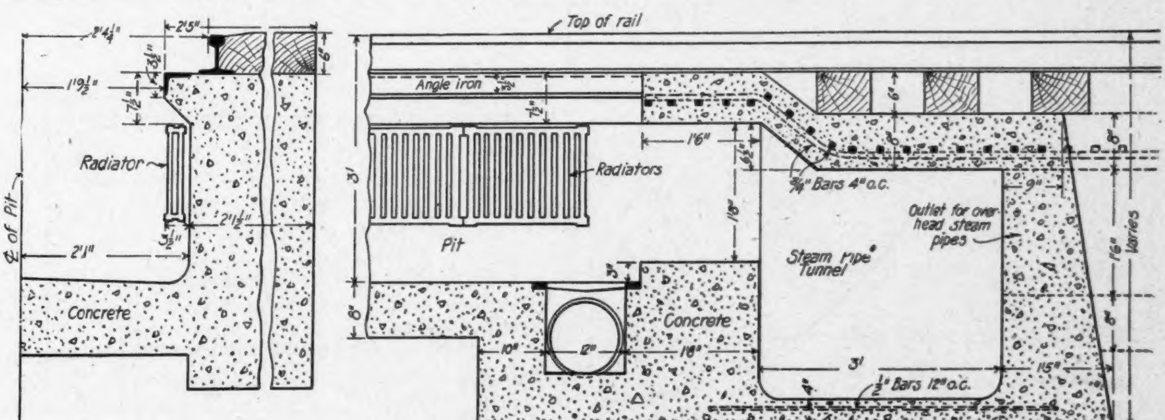
A building near the power house contains the roundhouse office, the road foreman of engine's office and the engine men's locker room and registry room. The locker room is equipped with the most modern sanitary fixtures available, has 248 steel lockers and two showers. This building has a slate roof. South of the machine shop building are located the two 100,000 gallon tanks. There are a number of small buildings scattered about, such as cinder pit shelters, yard master's office, scale house, etc. The yard master's office contains also a lunchroom and a restroom with 26 lockers.

The icehouse has a capacity of 4,000 tons and is divided into four compartments of 1,000 tons each. The construction of the walls, starting at the outside, is as follows: Siding, two-ply Giant paper, two-inch furring strips, ½-inch Flaxlinum, two-ply Giant paper, 1x6-inch sheathing, 1-ft. 5½-inch air space, 1x6-inch sheathing, two-inch cork and ½-inch plaster. The floor is covered with 2x6-inch planks with one-inch between. The building has a composition roofing. The icing platforms will accommodate eight refrigerator cars at a time, and the icing mechanisms are operated by motors placed in the roof gables.

The coaling station is a 600-ton skip hoist type, constructed by the T. W. Snow Construction Company of Chicago.

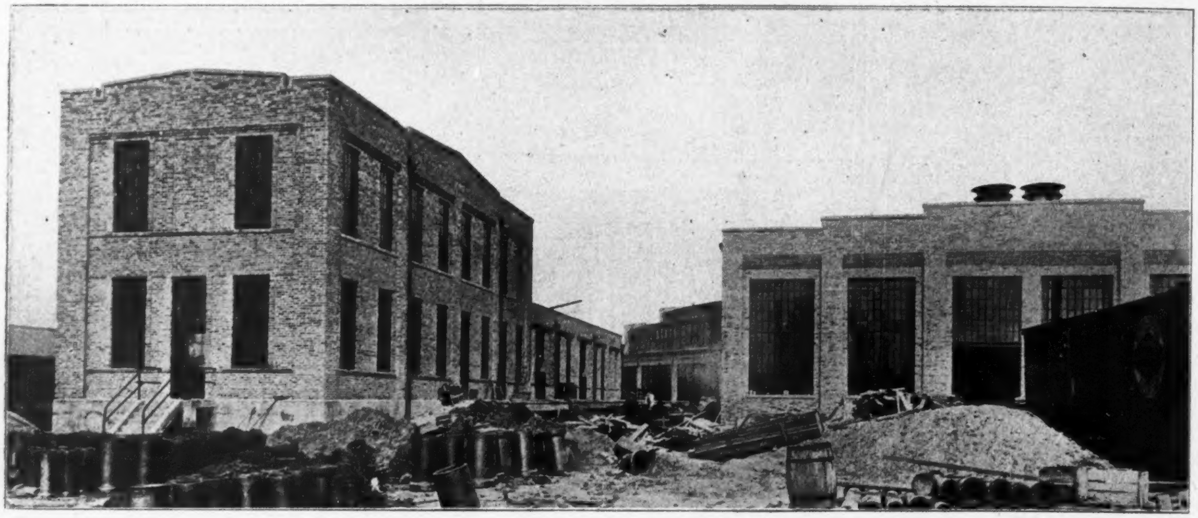
Car Department Group.

The central unit of this group is the open car repair shop, 90x500 feet. This is of rather an unusual type, there being but two roof slopes instead of four. This does away with center drains and provides a roof much neater in appearance. The roof is supported by wooden lattice trusses placed on 16-foot centers. The columns are 24 ins. square at bottom, beveled off at the top to fit the column bases. The first 15 feet is open and the next seven feet enclosed, although this latter space is practically all window space. The roof is plentifully supplied with skylights. There are four standard gage tracks running through the building, two on each side of the rows of



Half Section of Pit — Longitudinal Section of Pit on Center Line & Cross Section of Tunnel

Sections Through Roundhouse, Showing Heating Apparatus.



Office Building and Machine Shop.

posts down the center. There are also two material tracks, one between each set of standard gage tracks.

Ranged along the west side of the car shop are the wood mill, finished lumber shed, car wheel shop, etc. A glance at the layout drawing of this group shows that these buildings are so arranged that the movement of the material is continuous from one shop to another. The rough lumber is stored in the space south of the wood mill. From here it is taken into the wood mill and thence passes north to the finished lumber shed which is near the end of the car repair shop. At the north end of the car shed is the storehouse and car wheel shop. The wood mill has a concrete roof with two 36-inch ventilators, a concrete floor and Fenestra window sash. There is a narrow gage material track through the center. The machines have individual motor drive.

There are also in this group a paint storage building, office and division storehouse, two toilet houses and car wheel storage spaces.

Heating.

Two systems of heating are used; steam heat for the southern or locomotive department group and hot water for the northern or car department group. One of the reasons for adopting hot water for the northern group was on account of the difficulties to be encountered in connection with steam condensation and traps, the intervening ground being rather uneven in character. The two hot water pipes running to the car end were placed in a concrete box, which was fitted with a concrete cover. They were laid on expansion rollers, as shown in the sketch, and two expansion loops were placed in the 2,500-foot line.

From the power house to the roundhouse there is a concrete tunnel 4 ft. 6 ins. wide and 6 ft. high, with sides 1 ft. 8 ins. thick, with ¾ in. longitudinal and transverse reinforcing bars in the top slab spaced in 4 in. centers, and ½ in. transverse bars in bottom spaced on 6 in. centers, and ¾ in. longitudinal bars on 24 in. centers. It carries the steam and other pipes, and a conduit continues on to the machine shop and office building, carrying steam pipes and hot water pipes for washing and other purposes. This tunnel follows the inner circle of the roundhouse. Cast iron radiators are placed between the roundhouse windows and extend up some distance between them. A

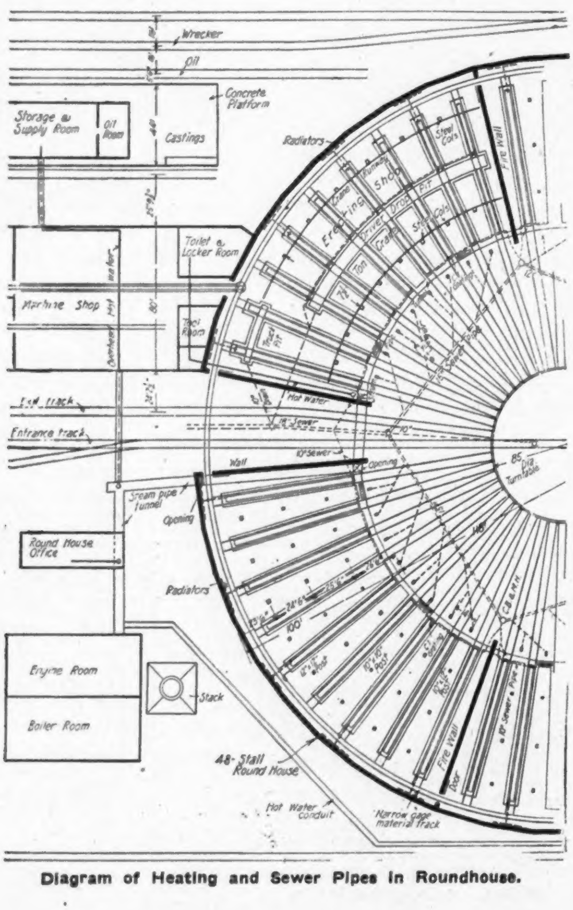
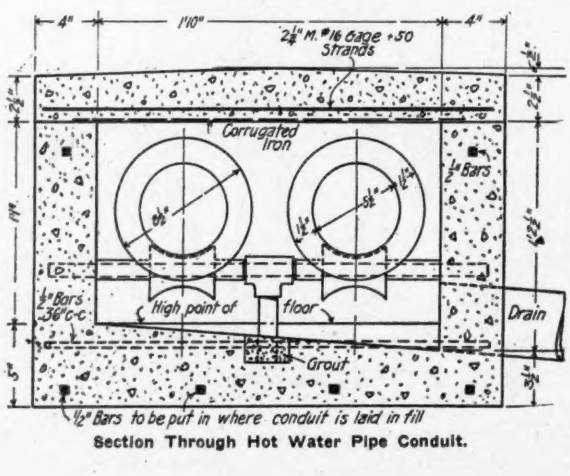


Diagram of Heating and Sewer Pipes in Roundhouse.



Section Through Hot Water Pipe Conduit.

riser is taken off from the tunnel steam pipes at a point near the outer circle, as they enter the building. This steam pipe continues around the outer circle just under the roof. From this pipe drops are taken to the wall radiators, and from these the steam passes into the pit radiators and thence to the steam tunnel at the inner circle. The radiators in the pits are also of cast iron and are placed in a recess. The drawing shows the placing of the pit radiators and also a section of the steam pipe tunnel. At frequent intervals around this tunnel there are oblong manholes with cast iron covers 8 feet in length. These allow the replacing of sections of pipe if necessary. Kehm Bros. Co., of Chicago, had the contract for the heating.

Lighting.

Tungsten lights are used almost entirely in lighting, being used in units of from 40 to 500 watts. They are used singly, except in the office, where clusters are used. In the roundhouse there are three lights to each stall, one 100 watts and two 250 watts, each light being suspended from the ceiling and having a Benjamin reflector. The drop pits are illuminated by lights placed in recesses. The lights above the crane-way in the erecting shop are 500 watts and 500-watt tungstens are also used in yard lighting.

General.

Fire protection is provided for by a motor-driven centrifugal pump. Water is supplied by the city of Centralia. There are both sanitary and storm water sewers, the latter emptying into a nearby creek, while the contents of the former are taken care of by a septic tank. A McFell Electric Co. fire alarm system is installed with pull boxes at various points and an indicator in the power house. All buildings are connected by a telephone system. Especially to be commended are the provisions made for the comfort and cleanliness of the men, not only by locker and toilet accommodations, but in the lighting and ventilation of the buildings.

For the data and illustrations given herein we are indebted to F. L. Thompson, engineer bridges and buildings; J. A. Taggart, architect, and Willard Doud, shop engineer of the Illinois Central. T. S. Leake & Co., of Chicago, had the general contract for the work.

The Duluth, South Shore & Atlantic is inquiring for 100 rock cars for the Mineral Range.

The Norfolk Southern, it is said, will be in the market for 500 cars.

The Western Maryland has placed an order with the Carnegie Steel Co. for 8,000 tons of rails.

The Carnegie Steel Co. has an order for 8,400 tons of rails from the Western Maryland.

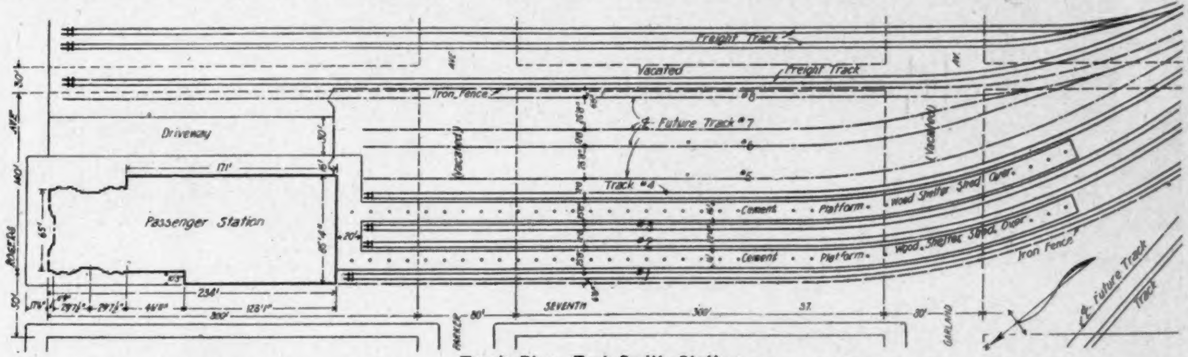
The Wheeling & Lake Erie, it is reported, has ordered 900 tons of steel for the ore-handling plant at Huron, O.

The Havana Central is said to be in the market for about 700 freight cars.

UNION STATION FORT SMITH, ARK.

A Union Station has recently been completed by the Kansas City Southern Ry., at Fort Smith, Ark., a very attractive structure being obtained for the appropriation available. The station building is situated at the corner of Rogers and Seventh Sts., facing northwest, with a main entrance 22 ft. wide on Rogers Ave. The building is one story high, the main portion, containing the main waiting room, being 57 ft. 7½ ins. to gable. The main entrance, illustrated herewith, is an elaborate arch with large arched windows above. There are four pairs of swinging doors, with ornamental lintels. On either side of the doors are decorative stone panels.

The station tracks terminate at the building, four tracks being provided in the present layout. South of the building the right of way is enclosed with a high iron fence. The property owned by the railway is sufficient for four more tracks east of the present passenger tracks; and the present plans provide for their future addition. That is, the track capacity of the terminal can easily be doubled in accord with the completed layout. There is room for still greater expansion, in that there are three stub end freight tracks beyond the 8 track provisional layout.



Track Plan, Fort Smith Station.

The main building rests on four large concrete piers, one at each corner. The rest of the building is supported on 4 continuous parallel walls, spaced about 26 ft. centers.

There are three large entrances—the main entrance on Rogers Ave., a smaller entrance on Seventh, and a carriage entrance opposite the latter. There is also a small entrance on Seventh St., opening into the colored waiting room.

The main waiting room is approximately square, with about 60 ft. clear space. The corners on the Rogers Avenue side are partitioned off into a telegraph station and a news stand. The main waiting room, lobby and concourse have cement floors on a 12 in. base, with pressed brick wainscot and plaster walls and ceilings.

Three large skylights give the lobby plenty of light from above. The glass skylights have 18 in. globe ventilators. Under each skylight is situated a large double seat. Entering the lobby from the waiting room there are on the left the mail room, United States Express room, Wells Fargo Express room, and the baggage room. There are no entrances from the lobby to the express and mail rooms, the entrances being from the outside of the building. The baggage room has window counters in both the lobby and concourse. On the right hand side of the lobby are situated the ladies' waiting room, ticket office, colored waiting room, and toilets. Entrance can be made directly from the lobby to the ladies' retiring room, or to the ticket offices, the other rooms having entrance from the concourse, the colored waiting room also having an entrance on Seventh St. The news stand and telegraph office have cement floors 8 inches thick, plastered walls, and plastered ceilings 10 ft. high.

The ladies' waiting room, and colored waiting room have

Fort Smith Passenger Station, K. C. S. Ry.

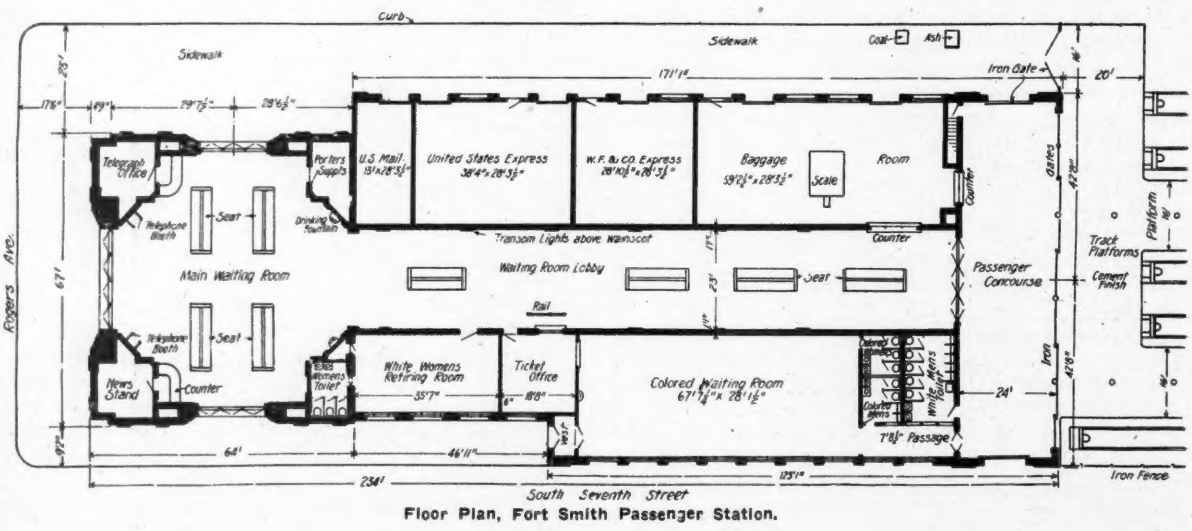
cement slab floors 8 inches thick, plastered walls and ceiling, wood picture mould and chair rail, with cement wainscoting between base and rail.

All floors are of concrete. Over the boiler room, or where the floors do not rest directly on the ground, there are I-beam and slab floors.

The boiler room is under the baggage room. It has a cement slab floor 6 ins. thick resting on a cinder fill. The top layer of the floor slab is a 1 in. layer of cement mortar.

The platforms, the present arrangement provides for two to serve the four tracks, are of concrete 16 ft. wide and 6 ins. thick on a 10 in. cinder fill, and are 600 ft. long. They are covered by wood shelter sheds, supported on center columns spaced 15 ft. apart.

The columns rest on concrete piers 3 ft. 6 ins. x 7 ft., and 3 ft. 6 ins. high. They are anchored by four 7⅛ in. bolts 3 ft. long. The cast iron shoe at base of columns is 1 ft. 3 ins. by 3 ft. and has an ornamental column receiving portion. The sheds are 600 ft. long. The roof is covered with composition roofing supported by 3 by 6 in. rafters and is 14 ft. 9 ins. high by 18 ft. wide. A 10 x 10 in. timber about 12 ft. long about 1 ft. below rafters, forms the support for

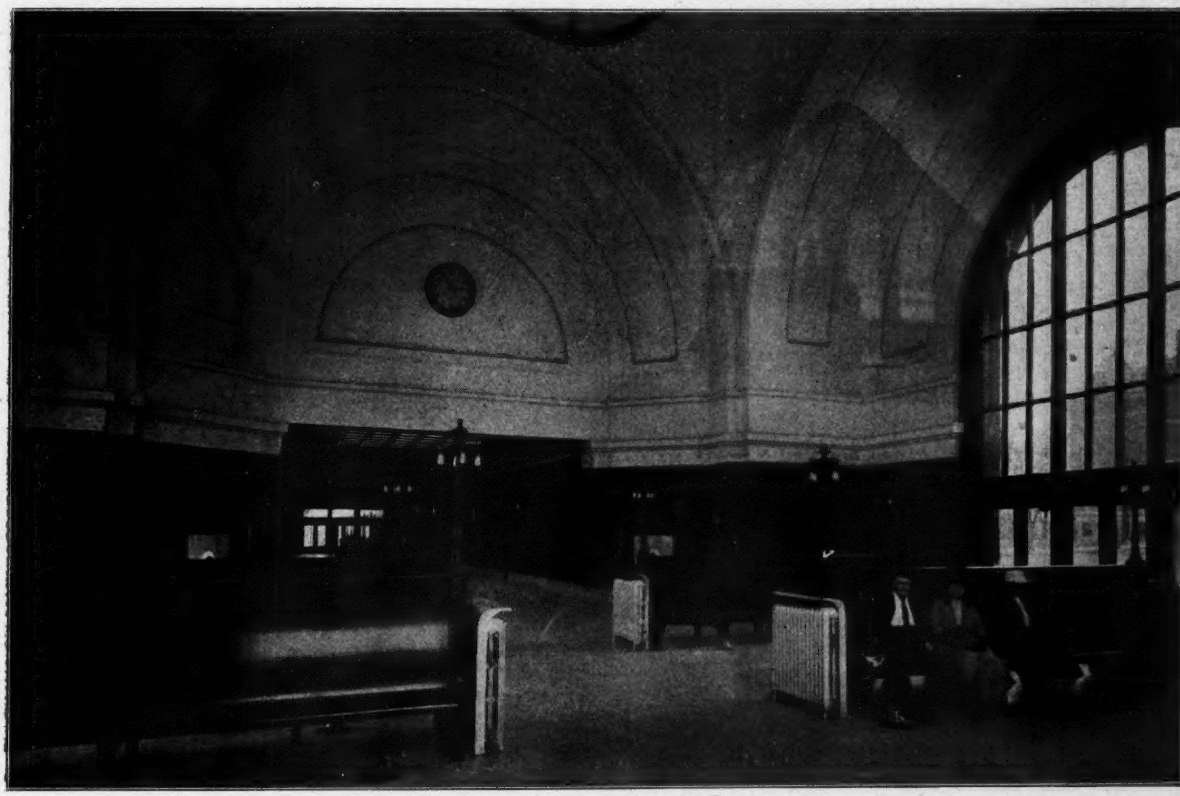


Floor Plan, Fort Smith Passenger Station.

the latter. Beyond this support the roof is supported by the rafters acting as cantilevers. Over the drain holes are small upwardly projecting wire baskets, which prevent dirt from getting into the drains. These are very easily cleaned by just sweeping the dirt away from them.

The tracks enter the terminal on a curve, the last three or four hundred ft. being on a tangent. The center pair of tracks with no platforms between, are on 12 ft. 8 in. centers. The tracks on opposite sides of the platforms are on 25 ft. 8 in. centers. The centers are spread from 13 ft. to those mentioned, just before entering the terminal. The grade into the station is + 0.16%.

The terminal was designed and erected under the supervision of C. E. Johnson, chief engineer of the Kansas City Southern Ry. Burnham & Sons, Chicago, were the architects of the building. We are indebted to Mr. Johnson and Burnham & Sons for the information and illustrations from which this article was prepared.



Main Waiting Room, Fort Smith Station.

The St. Louis Southwestern has ordered 10 ten-wheel locomotives and 10 consolidation locomotives from the Baldwin Locomotive Works.

The Wabash, Chester & Western has ordered one American type locomotive of the Baldwin Locomotive Works.

The Atlantic Coast Line is said to have placed orders with the Barney & Smith Car Co. for 1,000 box and 300 flat cars.

The Atlantic Coast Lines have ordered 1,000 steel underframe box cars and 3,000 steel underframe flat cars from the Barney & Smith Car Co.

The Baltimore & Ohio is reported to have issued inquiry for 1,000 hoppers and 500 refrigerator cars.

The Berwind White Coal Mine Co. has ordered 100 hopper cars from the Cambria Steel Co.

The Pennsylvania has divided orders for 12,300 cars among the various equipment concerns as follows: 4,500 coke cars with the Cambria Steel Co., 1,500 refrigerators and 1,000 gondolas with the American Car & Foundry Co., 500 box cars with the Western Steel Car & Foundry Co., 1,500 coke and 800 gondola cars with the Standard Steel car Co., 2,000 coke cars with the Pressed Steel Car Co. and 500 gondola cars with the Ralston Steel Car Co.

The Canadian Northern has placed an order with the Barney & Smith Car Co. for 5 dining cars.

The Chicago & Western Indiana is making an inquiry for 300 50-ton ballast cars.

The Chicago, Rock Island & Pacific has placed an order with the Western Steel Car & Foundry Co. for 1,000 box cars.

The American Refrigerator Transit Co., with the approval of its president, B. F. Bush, the president of the Missouri Pacific-Iron Mountain, has just placed an order for 2,000 cars with the American Car & Foundry Co. of St. Louis. These cars, which are to be delivered in the spring, will have steel underframes and every improvement known in the line of a refrigerator car. This big order for cars is necessitated by the large increase in traffic in perishable goods on the Gould Lines. The order just given, in conjunction with the contracts for new cars let in 1911 and 1912 after Mr. Bush came to the Missouri Pacific, means an increase in the equipment of the American Refrigerator Transit Co. of 157 per cent in the last two years.

The Baltimore & Ohio is reported to have placed orders with the Cambria Steel Co. for 10,000 tons of rails.

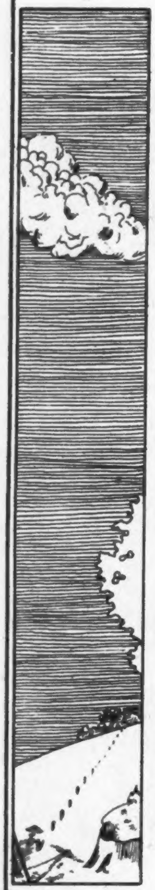
The Illinois Steel Co. has received the following orders: 1,500 tons of rails for the Great Northern, making its recent orders about 40,000, and 7,000 tons for the Waterloo and Cedar Rapids.

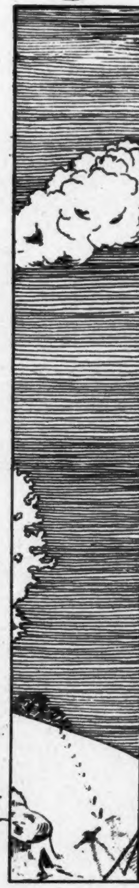
The Louisville has ordered 500 tons of girder rails from the Pennsylvania Steel Co.

The Southern has ordered 5 dining cars from the Barney & Smith Car Co.

The Engineer's Distress.

BY A S GUNN





THE ENGINEER

Who comes with faber sharpened keen,
With profile long and sober mein,
With transit, level, book and tape,
And glittering axe to swat the stake?
THE ENGINEER

Who sets the level, bends his spine,
Squints through the glass along the line,
Waves his arms at a rapid rate
And yells "Hold that bloomin rod up straight"?
THE ENGINEER

Who reads the numerals on the rod,
And hastily speeds along the sod,
The wriggling tape then with a shout,
Quick gives the distance out"?
THE ENGINEER

Who marks the fill on every stake,
With crimson keel of natures make,
And adds the shrinkage every time,
Which is perhaps his greatest crime?
THE ENGINEER

Who raves and snorts like one insane,
Jumps in the air and claws his mane
When'er he sees the scraper take
Liberties with his cherished stake?
THE ENGINEER.

Who swears he'll charge an even ten,
For stakes destroyed by mules or men,
While on all fours he tries in vane
To find the vanished stake again?
THE ENGINEER

Who saws the air with maddened rage,
And turns in haste the figured page,
And then with patience out of joint,
Tries in another reference point?
THE ENGINEER

Who after all commands the praise,
In spite of his peculiar ways,
While others harvest all the gain,
Which springs from his prolific brain?
THE ENGINEER

Who always finds a way to span,
The swiftest stream that ever ran,
And gives to commerce strength and speed,
To satisfy the Nations need"?
THE ENGINEER

Who throws his eye along the slope,
Where Celt with mattock loves to mope,
Then throws a clod and says "Right there"
Your out of line-about a hair"?
THE ENGINEER

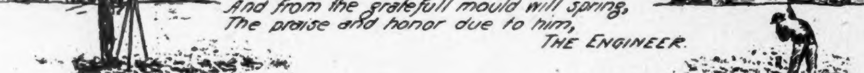
Who makes the hapless hobo yank,
Along the slippery inclined plank,
His jaded barrow full of muck,
When the hump is finished - just for luck?
THE ENGINEER

Who gives you the chilly eye
And says "I'll never classify
A cut with earthly indications"
And refers you to your specifications?
THE ENGINEER

Who deals in figures quit profuse,
Then tells you solid rock is loose,
That hard pan's nothing more than loam
While gumbo's lighter than sea-foam?
THE ENGINEER

Who points to your unrivalled gall,
When'er you kick for "over haul,"
And gives your spine the frigid chill
Whener you spring an extra bill"?
THE ENGINEER.

He will when science rules the mind,
Be hailed the saviour of mankind,
And from the gratefull mould will spring,
The praise and honor due to him,
THE ENGINEER.



The Song of the Timber Trail

by

Richard M Hunt.

1
I run me line
through spruce and pine
As straight as a rifle bore;
An the chainmen be to the
rear o'me,
An the swamper walks before.

2
Me compass aims to the point
I names,
An me swamper hews the way,
with the mighty whack of his
Yankee axe
That rings in the silent day.

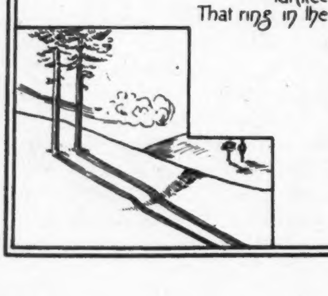
3
We never swerve
an' we never curve
For mountain tide or crag
We climb the hills
and we wade the rills,
As sure as a chargin stag.

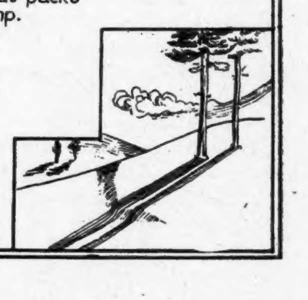
4
We work all day
In the forest way
On the palms of our buckhide feet,
An' we only plants the seat
of our pants
Come time for the midday eat.

5
When the treetops blaze in the
sun's last rays
An' the forest air grows damp,
We square our backs
to our canvas packs
An' hit the trail to camp.

6
An' the cook he bakes
some Johnny cakes,
An with ox from the sizzlin pan,
An a can o' goo
an some coffee too,
We feeds the feed of man

7
Then we lay our heads on balsam beds
As the glowin' fire gets pale,
An' we slumbers still in our blankets till
It's ho! for the timber trail.





Personals

Operating

Effective February 16, A. Syverson was appointed superintendent of the Ann Arbor R. R., office at Owosso, Mich., succeeding W. D. Holliday.

C. E. Brower has been appointed superintendent of the Atlanta, Birmingham & Atlantic R. R., at Fitzgerald, Ga., effective March 1.

B. R. Pollock, who was recently appointed general manager of the New York, New Haven & Hartford R. R., has been appointed general manager of the Boston & Maine R. R., effective February 6. Mr. Pollock's autobiography appeared in the January issue.

Grant Hall, who was appointed general manager of the Canadian Pacific, January 1, was born in Montreal, November 27, 1863, and was educated in Bishop's College, Lennoxville. He entered the service of the Grand Trunk Ry. as machinist's apprentice, and from 1890 to 1899 was locomotive foreman at Montreal. He was appointed general foreman, Canadian Pacific Ry. at McAdam in 1899, and was transferred to Winnipeg in 1901 in the same capacity. In the latter year he was appointed master mechanic of the Pacific division at Revelstoke, and was appointed assistant superintendent of rolling stock, eastern lines, in 1902. He was transferred to the western lines in the same capacity in 1904, and was made superintendent of motive power in 1908. He was appointed assistant general manager in 1911, and general manager January 1, 1913, office at Winnipeg, Man.

GRANT HALL,
General Manager Canadian Pacific Ry.

S. S. Russell has been appointed general superintendent of transportation of the Central Vermont Ry., office at St. Albans, Vt. J. F. O'Keefe has been appointed superintendent at St. Albans. J. McCraw has been appointed acting superintendent at New London, Conn.

S. S. Russell, general superintendent of transportation of the Central Vermont Ry., was born October 18, 1874, at Radnersville, Ont., and was educated in the public schools and at Belleville College. He entered the service of the Grand Trunk Ry. in 1891, in the office of the assistant superintendent at Belleville, Ont. In 1896 he was appointed secretary to the superintendent at Toronto, and in 1898 was appointed chief clerk to the joint superintendent of the Grand Trunk Ry. and the Wabash R. R. at St. Thomas, Ont. In 1902 he was appointed secretary to the vice-president and general manager of the Central Vermont Ry. at St. Albans, and in 1903 was appointed chief clerk to the superintendent of transportation, and later appointed to a similar position in the general manager's office. In 1911 he was appointed superintendent of car service, which position he held until his appointment as superintendent of transportation at St. Albans, Vt.

J. McCraw, acting superintendent of the Central Vermont Ry. at New London, Conn., entered railway service as an operator on the Northern & North Western Rys. in 1883, and held the position of agent at a number of locations. He was appointed agent on the Central Vermont Ry. in 1907 and became general agent in 1913, which position he held till his present appointment, which was effective February 1, 1913.

A. Ç. Harshaw, superintendent of the Canadian Pacific Ry. has been transferred from Calgary, Alb. to Cranbrook, B. C. H. E. Hannel has been appointed acting superintendent at Brandon, Man. W. Tansley has been appointed assistant superintendent at Havelock, Ont. W. B. Way, formerly assistant superintendent, has been appointed superintendent at Montreal, Que. J. K. McNeillie, superintendent, has been transferred from Farnham to Montreal, Que. J. K. Gilliland, superintendent, has been transferred from Montreal to Smith Falls, Ont. W. A. Cowan has been appointed acting superintendent at Brownville Jct., Me.

S. S. RUSSELL,
General Superintendent Central Vermont Ry.

F. H. Hammill has been appointed assistant general superintendent of the Chicago & Northwestern Ry. at Boone, Ia., effective February 17, with jurisdiction over the following divisions: East Iowa, West Iowa, Iowa & Minnesota, Northern Iowa, and Sioux City divisions. Mr. Hammill was born January 23, 1872, at Rockford, Ill., and entered the service of the Chicago & Northwestern Ry. as telegraph operator on the Galena division. He held successively the offices of chief train dispatcher of the Galena division, trainmaster of the Iowa division, and for the last seven years has been a superintendent, one year in Wisconsin and six years in Iowa.

F. J. Byington, formerly trainmaster of the Chicago &

Northwestern Ry. at Friendship, Wis., has been appointed superintendent at Boone, Ia., succeeding F. H. Hamill, promoted.

J. T. Gillick has been appointed assistant general manager of the Chicago, Milwaukee & St. Paul Ry. at Chicago, effective February 1. He entered the service of this company in 1884 as telegraph operator, and held successively the positions of train dispatcher, trainmaster and superintendent, holding the latter position at the time of his appointment as mentioned above.

F. M. Melin, superintendent of the Chicago, Milwaukee & St. Paul Ry., was transferred from Milwaukee, Wis., to Aberdeen, S. D., February 1, succeeding J. T. Gillick, promoted. N. P. Thurber has been appointed assistant superintendent at Milwaukee, Wis. Effective January 20, Mott Sawyer was appointed superintendent at Malden, Wash. J. A. MacDonald, superintendent, has been transferred from Ottumwa Jct., Ia., to Milwaukee, Wis., succeeding F. M. Melin. J. M. Oxley, superintendent, has been transferred from Chicago, Ill., to Ottuma Jct., Ia., succeeding Mr. MacDonald.

C. L. Ruppert, superintendent of the Chicago, Rock Island & Pacific Ry., has been transferred from Fort Worth, Tex., to El Reno, Okla., effective February 10.

A. B. Warner has been appointed superintendent of the Chicago, Rock Island & Gulf Ry. and the Chicago, Rock Island & Pacific Ry. at Ft. Worth, Tex., succeeding C. L. Ruppert, transferred. The appointment was effective February 10.

C. S. Wilkins, formerly trainmaster, has been appointed superintendent of the Coal & Coke Ry., office at Gassaway, W. Va., succeeding to the duties of J. A. Emmart, assistant general manager, who has resigned to enter private business.

George C. Randall, appointed superintendent of transportation of the Colorado & Southern Ry., effective February 1, was born in Northfield, Vt., March 31, 1883. He received his early railroad experience as clerk and telegraph operator on the Concord & Montreal Ry., and later was on the Boston & Maine R. R. He graduated in the class of 1904 from Norwich University, and immediately took service with the Colorado & Southern Ry. and has been with them continuously since as clerk in the superintendent's office at Cheyenne, Wyo., 1904; chief dispatcher, 1904. He was appointed chief clerk in the car service office, Denver, Colo., in 1906, which position he held until his present appointment.

Caleb Corser has been appointed superintendent of the Copper River & Northwestern Ry. office at Cordova, Alaska, succeeding George Geiger.

C. B. Carpenter has been appointed inspector of transportation of the Denver & Rio Grande R. R. at Denver, Colo., effective February 1.

C. J. Wilson has been appointed superintendent of the Duluth, Winnipeg & Pacific Ry. at Virginia, Minn., effective February 24.

W. E. Gillen, general superintendent of the Grand Trunk Ry., has been transferred from Montreal, Que., to Chicago, Ill. D. Gilmour has been appointed superintendent at Seattle, Wash., succeeding R. W. Scott.

W. E. Costello has been appointed superintendent of the Houston & Texas Central R. R. at Ennis, Tex., succeeding D. S. Gallagher.

Effective February 1st, W. E. Higgins was appointed acting vice-president and general manager of the Lackawanna & Wyoming Valley R. R. at Scranton, Pa. He entered the employ of the Old Colony R. R. in 1893 as stenographer in the general freight office at Boston, Mass., which road was soon afterward leased by the New York, New Haven & Hartford R. R. In 1895 he was assigned to special work by the president of that road, and in 1896 was appointed clerk in the treasurer's office, Boston Terminal Co. In 1900 he became stenographer for the fourth vice-president of the New York, New Haven and Hartford Railroad at Boston, and in 1903 was appointed chief clerk to vice-president of the Lackawana & Wyoming Valley Railroad, at Scranton, Pa. He was appointed assistant to general manager in 1909, which position he held till his present appointment.

S. M. Woodard has been appointed superintendent of the Manufacturers' Railway of St. Louis, effective February 1. He succeeds J. J. Baulch, deceased.

J. A. Somerville has been appointed superintendent of transportation of the Missouri Pacific Railway, at St. Louis, Mo., effective February 13. He entered railway service with the Chicago, Burlington & Quincy Railroad, at Keokuk, Iowa, in 1887, and remained with that company until 1908, holding the positions of yard agent, station agent, and local agent at Keokuk and St. Louis, general agent at Hannibal, Mo., and Keokuk, Iowa, and superintendent at St. Louis. He entered the service of the Missouri Pacific Railway as superintendent at Kansas City, Mo., which position he held till his recent appointment as superintendent of transportation.

E. T. Kearney has been appointed general superintendent of the Missouri Pacific Railway at St. Louis, Mo. J. A. Shepard has been appointed superintendent of terminals at Kansas City, Mo., effective February 1, succeeding J. A. Somerville.

Miles Bronson has been appointed general superintendent of the New York Central & Hudson River Railroad, Electric division, and also manager Grand Central Terminal Railway, effective February 1. He entered railway service in 1890 with the Grand Trunk Railway, law department, and was appointed secretary to president of the New York, Chicago & St. Louis Railroad in 1895. He was appointed secretary to president, New York Central & Hudson River Railroad, in 1898, and became superintendent of the Harlem division in 1900; subsequently he was transferred in a similar capacity to the River division in 1907, to the Mohawk division in 1910, and to the Electric division and Grand Central Terminal in 1911. He held the latter position at the time of his appointment February 1.

Garrett H. Wilson has been appointed superintendent of the New York Central & Hudson River Railroad, Electric division, and also superintendent of the Grand Central Terminal, office at New York. He was born in 1867 and graduated from the Lambertville, N. Y. high school, in 1883. He entered the service of the Pennsylvania Railroad in 1889 as telegraph operator, and entered the service of the Central Railroad of New Jersey in 1885 as telegraph operator, later being appointed train dispatcher. In 1887 he was appointed train dispatcher of the New York, New Haven & Hartford Railroad, and later was promoted to chief train dispatcher, and then to superintendent. He resigned in 1905 to engage in mercantile business, and re-entered railway service as train dispatcher with the New York Central & Hudson River Railroad, in 1907, as train dispatcher. He held successively the positions of chief train dispatcher and assistant superintendent till his appointment as superintendent February 1.

A. R. Whaley has been appointed vice-president of the New York, New Haven & Hartford Railroad, in charge of operation, succeeding H. J. Horn. C. L. Bardo has been appointed general manager, succeeding B. R. Pollock, who has gone with the Boston & Maine Railroad.

T. F. Lowry, formerly trainmaster, has been appointed superintendent of the Northern Pacific Railway at Dilworth, Minn., succeeding K. M. Nichols, effective February 1.

J. H. Harris has been appointed general manager of the Peoria Terminal Ry., office at Peoria, Ill., succeeding J. H. Franke.

J. E. Farrell has been appointed assistant to the general manager of the Northern Ry., of Costa Rica, office at San Jose, Costa Rica.

N. W. Jones has been appointed inspector of transporta-

tion of the Philadelphia & Reading Railway at Reading, Pa., effective February 1.

J. W. Walters has been appointed assistant superintendent of the St. Louis, Brownsville & Mexico Railway at Kingsville, Texas, effective February 1.

E. S. Heyser has been appointed general superintendent of the San Benito & Rio Grande Valley R. R. at San Benito, Tex., effective February 1. He entered railway service as levelman on the St. Louis, Brownsville, & Mexico Ry. in 1902, and subsequently held the positions of resident engineer on construction, assistant engineer on maintenance, and division roadmaster and trainmaster. He left the service of the St. Louis, Brownsville & Mexico Ry. February 1 to accept the position as noted above.

J. W. Williams, who was appointed assistant general superintendent of the Southern Pacific R. R. of Mexico at Empalme, Son., Mex., effective January 17, entered railway service in 1895 as clerk in the office of the Texas Central R. R. at Waco, Tex. He went with the Sonora Ry. as clerk and stenographer, and left to accept a position in the accounting department of the St. Louis, Southwestern Ry. at Tyler, Tex. In 1905 he was appointed chief clerk to superintendent of the Gila Valley, Globe & Northern R. R. at Globe, Ariz., and later became private secretary to Epes Randolph, president. In 1907 he was appointed trainmaster and roadmaster of the Globe, Arizona & Colorado R. R. and was later appointed superintendent of the Arizona & Colorado R. R. He was appointed clerk to vice president and general manager of the Arizona Eastern R. R. and Southern Pacific R. R. of Mexico, from which position he was promoted to superintendent of the Sinaloa division of the Southern Pacific R. R. of Mexico. He was promoted to general superintendent January 17.

G. L. Anderson has been appointed general manager of the Sumpter Valley Ry., office at Baker City, Ore.

Engineering

L. C. Maxwell has been appointed engineer maintenance of way of the Algom Central & Hudson Bay Ry., office at Sault Ste. Marie, Ont.

M. A. Long, formerly architect, has been appointed assistant to chief engineer of the Baltimore & Ohio R. R., Baltimore, Md. The appointment was effective February 1. Mr. Long was born on a farm near Middletown, O., October 25, 1875, and received his elementary education in the public schools of Middletown and Dayton, O., later taking the course in architecture and railroad engineering with the Scranton Schools. He first entered Baltimore & Ohio R. R. service June 5, 1899, as architect and assistant on engineering corps, being advanced to architect of that road in 1904, which post he has held up to the time of his recent promotion to assistant to chief engineer. He is a member of the American Society of Engineers, the American Institute of Architecture and is vice-chairman of the Building committee of the American Railway and Engineering Association.

L. C. James, resident engineer of the Baltimore & Ohio R. R., has been transferred from Ellwood City, Pa., to Youngstown, O.

F. J. Parrish has been appointed first assistant engineer of the Baltimore & Ohio Southwestern R. R. at Cincinnati, O., succeeding C. R. Diemar.

R. C. Reamer, formerly division engineer of construction, has been appointed architect of the Boston & Maine R. R., office at Boston, Mass. G. L. Huckins has been appointed division engineer of construction at Boston, Mass. C. J. Griffin has been appointed division engineer of construction at Greenfield, Mass.

T. W. Fatherson, formerly division engineer, has been appointed engineer maintenance of way of the Chicago, Rock Island & Pacific Ry., El Reno, Okla., effective February 10.

D. S. Terry has been appointed construction engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Cincinnati, O., succeeding F. W. Smith, effective February 17.

H. S. Rogers has been appointed maintenance engineer of the Delaware & Hudson Co., at Albany, N. Y.

T. T. Irving has been appointed resident engineer of the Grand Trunk Ry. at Chicago, Ill. F. L. C. Bond, formerly assistant engineer, has been appointed resident engineer at Montreal, Que. M. S. McCulloch has been appointed assistant engineer at Montreal, Que. O. H. Sessions has been appointed assistant engineer at Battle Creek, Mich. F. P. Sisson has been appointed assistant engineer at Detroit, Mich.

A. H. Hogeland, formerly chief engineer, has been appointed consulting engineer of the Great Northern Ry. St. Paul, Minn., Ralph Budd, formerly assistant to president, succeeds Mr. Hogeland as chief engineer, office at St. Paul. M. C. Byers, formerly chief engineer of operation, St. Louis & San Francisco Ry. has been appointed assistant to president, suceeding Ralph Budd. Effective January 24, H. F. Hamilton was appointed resident engineer of the St. Paul district, office at St. Paul, Minn., succeeding F. B. Walker resigned. P. S. Hervin has been appointed resident engineer of the Minot district, office at Minot, N. D., succeeding H. T. Hamilton.

M. A. LONG,
Asst. Chief Engineer Baltimore & Ohio R. R.

P. S. Hervin, resident engineer of the Great Northern Ry., entered the service of this company in July, 1888, and held subsequently the position of assistant engineer on maintenance and construction till 1906, when he was appointed resident engineer at Grand Forks, N. D. He was transferred to Great Falls, Mont., in 1908, and has been in charge of construction in Montana since 1911, till appointed resident engineer at Minot.

L. C. Dupuis has been appointed resident engineer of the Intercolonial Ry. of Canada, office at Levis, P. Q. C. C. Duberger has been appointed assistant engineer of construction at Moncton, N. B., succeeding A. C. Selig. H. J. McGrath has been appointed inspector of piece work.

J. W. Crissey has been appointed assistant engineer of construction of the Lake Shore & Michigan Southern Ry. at Cleveland, O., effective February 10. He will have charge of grade separation and other construction work. For the past 7 years he has been in charge of track elevation at Chicago, as resident engineer.

H. W. Fenno has been appointed resident engineer of the Lake Shore & Michigan Southern Ry. at Chicago, succeeding J. W. Crissey, promoted. Mr. Fenno entered the service of the Boston & Albany R. R. in 1891, and was located on grade separation work till 1904. In that year he entered the service of the L. S. & M. S. Ry. and was made resident engineer of the Eastern division in 1906. He was transferred to Chicago February 10.

S. W. McClure has been appointed resident engineer of the Lake Shore & Michigan Southern Ry. at Erie, Pa., succeeding H. W. Fenno, transferred. He has been with the L. S. & M. S. Ry. for 9 years, holding positions from chainman up. His present appointment took effect February 10.

J. G. Sheldrick has been appointed resident engineer of the Minneapolis, St. Paul & Saulte Ste. Marie Ry. at Superior, Wis., effective February 1. He entered the service of the Chicago, St. Paul, Minneapolis, & Omaha Ry. in 1898, as rodman, was appointed mason inspector in 1900, and in 1903 went with the Minneapolis, St. Paul & Sault Ste. Marie Ry. as rodman. Later in 1903 he became track engineer, in 1904 was engineer on bridge work, and later the same year was made resident engineer on construction. In 1905 he was appointed assistant engineer, which position he held till his recent appointment.

H. H. Trabue, formerly assistant real estate agent, has been appointed assistant chief engineer of the Nashville, Chattanooga, & St. Louis Ry. effective January 20.

P. B. Spencer has been appointed division engineer of the New York, New Haven & Hartford R. R. at New Haven, Conn. A. S. Tuttle has been appointed division engineer at Boston, Mass.

J. B. Hutchinson, Jr., has been appointed division engineer of the Northern Central Ry. at Williamsport, Pa., succeeding J. R. Sinnickson.

F. J. Jonah, formerly chief engineer of construction, has been appointed chief engineer of operation, St. Louis & San Francisco Ry., office at Springfield, Mo., succeeding M. C. Byers, who has accepted service with the Great Northern Ry.

O. Gumper has been appointed assistant engineer of the Southern Ry. at Birmingham, Ala.

V. K. Hendricks, formerly principal assistant engineer, has been appointed assistant chief engineer of the St. Louis & San Francisco Ry., office at Springfield, Mo.

C. C. Ohliger has been appointed assistant division engineer of the Vandalia R. R., at Indianapolis, Ind.

M. C. Meigs has been appointed assistant engineer of the Yazoo & Mississippi R. R. at Vicksburg, Miss., succeeding J. W. Kern, Jr., effective February 1.

Maintenance of Way

L. B. Scherman, Jr., has been appointed roadmaster of the Brinson Ry., at Savannah, Ga., effective February 1.

L. C. Grubbs, supervisor of track of the Chesapeake & Ohio Hy., has been transferred from Hinton to Huntington, W. Va., succeeding R. W. Mumford, who succeeds R. C. Patton as supervisor of track at Thurmond, W. Va. R. C. Patton succeeds C. A. Stanley as supervisor of track at Hinton, W. Va., and C. A. Stanley succeeds L. C. Grubbs as supervisor of track at Hinton, W. Va. These changes were effective February 1.

E. W. Budd has been appointed roadmaster of the Chicago, Indianapolis & Louisville Ry. at Bedford, Ind., vice J. A. Shoulty.

N. T. Blackwell has been appointed roadmaster of the Chicago, Rock Island & Pacific Ry. at Windsor, Mo., effective February 1.

P. Toomey has been appointed assistant supervisor of the Erie R. R. at Binghampton, N. Y.

The title of general roadmaster on the Grand Trunk Ry. has been changed to superintendent of track, affecting G. Beckingham at Montreal, Que.; W. Bibby, Allandale, Ont.; Henry Ferguson, Toronto, Ont.; A. Grills, St. Thomas, Ont., and J. H. Reagan, Battle Creek, Mich. D. McCooe has been appointed superintendent of track at Toronto, Ont. The title of roadmaster has been abolished and supervisor of track substituted. J. Cotter has been appointed supervisor of track at Battle Creek, Mich., effective February 1. H. Plownan, supervisor, has been transferred from Detroit, Mich., to Milwaukee Jct., Mich.

R. J. O'Connor, formerly assistant roadmaster, has been promoted to roadmaster of the Great Northern Ry. at Grand Forks, N. D., effective February 17, succeeding F. J. Heinen. Thomas Riley has been appointed roadmaster at Havre, Mont., succeeding G. G. Smart, effective February 13. G. G. Smart, roadmaster, has been transferred from Havre, Mont., to Everett, Wash.

J. V. Murphy has been appointed roadmaster of the Houston & Texas Central R. R. at Ennis, Tex., succeeding L. Acker, effective February 1.

M. M. Backus supervisor of the Illinois Central R. R., has been transferred from Carbondale, Ill., to Princeton, Ky., succeeding J. McNamara. J. W. Kern, Jr., has been appointed supervisor at Carbondale, Ill., succeeding M. M. Backus, effective February 1.

H. Spinney has been appointed roadmaster of the Intercolonial Ry. of Canada at Picton, N. S., succeeding J. C. Fulmore, who has been transferred to Truro, N. S., as roadmaster, succeeding G. W. Archibald.

J. O. Ely, roadmaster of the Louisville & Nashville R. R., has been transferred from Nashville, Tenn., to Lexington, Ky. C. W. Moorman has been appointed roadmaster at Versailles, Ky.

E. G. Lang has been appointed roadmaster of the Missouri, Kansas & Texas Ry. of Texas, at Greenville, Tex.

W. D. Bagby, roadmaster of the Missouri Pacific Ry., has been transferred from Herrin, Ill., to Charleston, Mo., succeeding E. E. Arthur, effective January 28. S. J. Karsteter, roadmaster, has been transferred from Cairo to Herrin, Ill., succeeding W. D. Bagby. J. E. Bone, roadmaster has been transferred from Malvern, Ark., to St. Louis, Mo. R. H. Holm has been appointed roadmaster at Cairo, Ill., succeeding S. J. Karsteter.

J. C. Hill has been appointed roadmaster of Morgan's Louisiana & Texas R. R. at Morgan City, La., succeeding J. W. Moore.

A. F. Stotler, formerly roadmaster, has been appointed general roadmaster of the Northern Pacific Ry. at Seattle, Wash. Ralph Morris has been appointed roadmaster at Seattle, Wash., succeeding A. F. Stotler.

H. A. Gass has been appointed supervisor of the Pennsylvania R. R. at Wilkesbarre, Pa., succeeding W. F. Courts.

W. W. Hubley has been appointed assistant supervisor of the Pennsylvania R. R. at Altoona, Pa., succeeding H. A. Gass, promoted.

R. M. Garnett has been appointed roadmaster of the St. Louis, Brownsville & Mexico R. R. at Kingsville, Tex.

W. E. Midkiff has been appointed roadmaster of the Southern Ry. at Alexandria, W. Va., succeeding M. Murphy, effective February 1.

Ed Warren has been appointed roadmaster of the Southern Kansas Ry. of Texas, at Canadian, Tex., succeeding W. F. Hart.

D. A. White has been appointed roadmaster of the Southern Pacific R. R. of Mexico.

Bridges and Buildings

W. R. Golsen has been appointed supervisor of bridges and buildings of the Central of Georgia Ry. at Macon, Ga., succeeding A. S. McMillan. The appointment was effective January 15.

Ed Gebhart has been appointed master carpenter of the Chicago & Alton Ry. at Bloomington, Ill.

B. Anderson has been appointed master carpenter of the Chicago, Burlington & Quincy R. R. at Wymore, Neb.

H. H. Eggleston has been appointed superintendent of bridges and buildings of the Chicago Great Western R. R. at Des Moines, Ia. The appoinment was effective January 15.

G. Dyson has been appointed general supervisor of bridges and buildings of the Grand Trunk Ry., office at Montreal, Que., effective February 1. H. G. Batter was appointed supervisor of bridges and buildings at Detroit, Mich., and G. Sanders was appointed supervisor of bridges and buildings at Battle Creek, Mich. The title of master of bridges and buildings has been abolished. G. A. Mitchell is now superintendent of bridges and buildings of Toronto, Ont., H. C. Swarz is superintendent of bridges and buildings at St. Thomas, Ont., and W. H. Tool is superintendent of bridges and buildings at Allandale, Ont. C. D. Busbey has been transferred from Durand, Mich., to Chicago ,and now has the title of superintendent of bridges and buildings. J. H. Johnson has been appointed superintendent of bridges and buildings at Montreal, Que.

E. D. Reinking has been appointed chief carpenter of the Kalispell division of the Great Northern Ry., office at Whitefish, Mont., effective February 1.

Signaling

R. F. Morkhill has been appointed signal engineer of the Grand Trunk Ry., with office at Montreal, vice Mr. C. A. Dunham, resigned, effective March 1st. Mr. Morkhill is a native of Sherbrooke, Que., and is an electrical engineer by profession. A little more than six years ago he was in charge of the signalling on the Central South Africa Ry. after the war, organizing the signalling system on that road. He was then employed in the head sales office, at New York, of the Union Switch & Signal Co., and was later one of the assistant engineers in the construction of the Pennsylvania Railway's New York Terminals. Later Mr. Morkhill joined the Railway Signal Company of Canada, Ltd., which was then being organized, as sales manager. Last August he was made assistant general manager of this company, a position he has held up to the present time.

F. L. Wells, signal supervisor of the Chicago & Northwestern Ry., has been transferred from Boone, Ia., to Chicago, Ill., succeeding C. G. Stecher, who has been appointed signal instructor. K. E. Kellenberger has been appointed signal supervisor at Boone, Ia.

C. A. Dunham has been appointed signal engineer of the Great Northern Ry., office at St. Paul, Minn.

J. O. Massie has been appointed signal supervisor of the Louisville & Nashville R. R. at Knoxville, Tenn., effective February 1. H. E. Smith has been appointed general signal foreman, terminals, at Nashville, Tenn., effective February 12.

L. H. Hassel has been appointed signal inspector of the New York Central & Hudson River R. R. at Albany, N. Y. G. D. Hill, assistant signal supervisor, has been transferred from New York to Poughkeepsie, N. Y.

O. F. Dorward, formerly signal inspector, has been appointed signal supervisor of the New York, New Haven & Hartford R. R., office at Boston, Mass. A. J. Warren has been appointed signal inspector at Boston; J. H. Boylett, T. Johnson and John Allen have been appointed signal inspectors at New Haven, Conn.

The Baltimore & Ohio has ordered 60 Mikado locomotives and 30 Pacific locomotives from the Baldwin Locomotive Works. This road has also given an order to the American Locomotive Co. for 10 mallet articulated compound superheater locomotives with 26x41x32 in. cylinders, driving wheels 57 ins. in diameter.

The Chesapeake & Ohio has ordered nine locomotives from the American Locomotive Co.

EXHIBITS.

The increasing interest which is being taken in exhibits of railway supplies is witnessed by the action of the American Railway Engineering Association in setting aside one day of the Annual Convention, for a visit to the exhibit of the National Appliances Association.

The educational value of these exhibits has long been appreciated by many railway officials, some of whom arrange each year to have all subordinates, as far as possible, attend the exhibit, allowing them release from duty for a day or two for this purpose.

The efforts of the Supply Associations are certainly deserving of the support of railway officials. Every year a greater attempt is made to gather together all those firms which have devices of proven worth, and others which appear to have meritorious supplies. And an effort is also made to exclude those whose devices are not thought to be dependable or practical, although it is not always easy to exclude those whose wares are not practical.

The opportunity for comparison of different devices is unequalled, at an exhibit such as that of the National Appliances Association; and it is well worth the time and attention of the railway official to be able to judge of the comparative merits of devices such as he is already using, to say nothing of the opportunity of examining quickly and advantageously a large number of new devices.

The Erie has ordered 10 Pacific type locomotives from the American Locomotive Co.

The Hang Yang Iron & Steel Works has ordered 2 four-wheel saddle tank locomotives from the American Locomotive Co.

The Kansas City Southern has ordered 4 six-wheel superheater switching locomotives with 20x28 in. cylinders, driving wheels 50 in. in diameter and a total weight of 156,000 lbs. in working order, from the American Locomotive Co.

The J. D. McArthur Co. has ordered mogul freight locomotives from the Montreal Locomotive Works.

The Midland Pennsylvania has ordered an American type locomotive from the Baldwin Locomotive Works.

The Missouri Pacific has ordered 5 Mikado locomotives from the Baldwin Locomotive Works.

The New York Central Lines are reported to be in the market for 38 switching locomotives, 3 mallet locomotives, 13 Pacific locomotives and 50 Mikado locomotives.

The Chesapeake & Ohio, it is reported, is in the market for 15 steel passenger cars, 3 steel combination cars, 2 steel dining cars and 2 steel postal cars.

The Chicago, Rock Island & Pacific has ordered 50 cabooses from the Whipple Car Co.

The Erie has ordered 1,500 freight cars from the Western Steel & Foundry Co.

The Oregon Short Line is reported to be in the market for 800 gondolas in addition to cars recently ordered by the Harriman Lines.

The Pennsylvania, it is reported, will build 80 passenger cars in its Juniata shops.

The Duluth & Northern Minnesota is reported to have ordered 2,000 tons of rails.

The Transcontinental is in the market for 6,000 tons of 80-pound rails.

The Western Maryland, it is reported, ordered 8,100 tons of 90-pound rails, dividing the contract between the Bethlehem Steel Co. and the Carnegie Steel Co.

The Atchison, Topeka & Santa Fe, it is reported, will build a wheel shop at San Bernardino, Cal. It is also reported that plans have been made for improvements on its elevators at Argentine, Kan. These will cost about $353,000.

The Baltimore & Ohio, it is reported, plans building a new bridge over the Allegheny river at Pittsburgh, Pa., to cost $2,500,000.

OLD CIRCULAR OF RAILWAY EQUIPMENT.

The accompanying illustrations are taken from a circular issued in 1858 by the owners of "Halladay" wind mills and "Curtis" pumps, still a part of the product of the U. S. Wind Engine & Pump Co., which was incorporated to manufacture these devices in 1857, although it was organized in 1854. The concern built a plant, which has since been extended several times, at Batavia, Ill., and it now maintains its general offices at that place. The company now makes a specialty of the manufacture of railway water supply stations and switch stands, and it is said that this concern is the largest manufacturer of tanks in the world.

The first officers of the company were: John Van Nortwick, president and treasurer; Daniel Halladay, secretary; and John Burnham, general agent. The present officers are W. D. Turner, president; A. D. Mallory, vice president; L. B. Turner, second vice president; and A. J. Roeffs, superintendent. L. E. Wolcott is in charge of railway and contract sales for the company.

The circular illustrated was considered a very good exposition of the printer's art fifty-four years ago. The woodcuts are hand wrought and were produced at considerable expense. They served the purpose of attracting attention and expressing the idea. Eleven wind mills may be counted in the larger illustration.

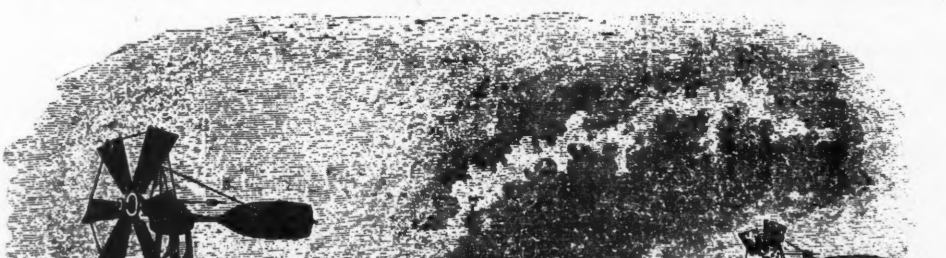
The circular is principally given over to the comparison of wind and steam power with argument in favor of the former. Steam power is spoken of as "limited to mechanical bounds" and existent "only by an expensive consumption of the very elements by which it is created and exists, while it is extremely liable to calamitous explosions."

The testimonials shown in the second illustration are mostly from railway officials, and the signatures will be recognized by many among the older generation of railway men.

HALLADAY'S PATENT WIND MILL,

AND

CURTIS' RAIL ROAD PUMP.



PERFECT PRACTICABILITY OF WIND POWER.

Hitherto, attempts to apply *wind* as a stationary *power*, for farm and other purposes, have succeeded only indifferently, and given but partial satisfaction. All former inventions would lack self-regulating powers, and require constant attention and control by man; but these recent inventions have removed all such difficulties, so that they may be left days and weeks—in gales and calms—requiring no other care, than simply to be kept well oiled. By this contrivance the Mill and Pumps will stop whenever the tanks and reservoirs are full; and the *regulator* may be set so that the velocity and wear will not be increased beyond any desired motion, in even the stiffest gales. This invaluable and beautiful invention, with the admirable Wind Engines and Pumps, to which it belongs, is the work of DANIEL HALLADAY, of Connecticut.

These Mills, with the self-regulator, have now been in use and severely tested over four years, and not a single failure has ever come to the knowledge of the inventors and makers. It is the only Mill ever invented, which, in all winds and gales, is as fully under the control of the water-regulator as the steam engine is of the governor; the only self-regulating mill that has proved itself under long and severe exposure. This great success is attained by a cheap, simple and ingenious device, by which, as the wind increases, the fans or wings gradually turn from the angle at which they stand for a moderate breeze, till they present less and less surface to the wind, as it gets stronger, until it blows a tempest, when nothing but the thin edges are presented to its power. As the gale abates, the fans turn their surface again to the breeze, and resume their original position.

SUPERIORITY OF WIND POWER OVER OTHERS.

The *wind* is the most universal, and accessable motive power within the reach of man; it is unbounded, and is not in the power of one man to prohibit or restrict its use by his fellow-man. *Steam* is a good and mighty motive power, but is limited to mechanical bounds, and is produced by the mechanical combination of two or more substances, and can exist and be used *only* by an expensive *consumption* of the very elements by which it is created and exists; while it is severely liable to calamitous explosions—destroying vast amounts of lives and property. *Water* is another vastly useful power

Reproduction of a Part of a Circular Issued in 1858.

TESTIMONIALS:

OFFICE GALENA & CHICAGO UNION RAIL-ROAD Co,
Chicago, Jan. 18, 1858.

There is now at work on this road five of "Halladay's Patent Wind Mills." The first one was erected in this city fifteen months since, and paid for itself in labor saved the first year.

From the experiments made in the use of these wind mills I am satisfied they are the cheapest power for raising water that can be used on the line of a Railroad; and where suitable tank room is furnished, any station can be supplied with one. During a press of business last season thirty trains were daily supplied with the mill in this city. It is the intention to adopt them throughout the entire line of our road.

Yours truly, P. A. HALL, Supt.

To JOHN BURNHAM.

CHICAGO, ST. PAUL & FOND DU LAC R. R. OFFICE.
Chicago, January 18, 1858.

MR. JOHN BURNHAM, Agent Wind Mill Co.,—*Dear Sir:*—I take pleasure in certifying that the three wind mills put up by you last spring, for pumping water, have all worked perfectly and to my entire satisfaction, having given us no trouble whatever, thus far, and if asked I would advise all railroads to adopt them as the most economical and reliable plan that has ever been brought to my notice.

Yours, respectfully, S. F. JOHNSON, Chief Engineer and Supt.

OFFICE OF CHICAGO, BURLINGTON & QUINCY R. R. Co.,
Jan. 28, 18'8.

We have given your "Hallady Wind Mill and Curtis' Pump" a trial of three months, at our water station at Galena Junction, and find it to work admirably well. We kept four men to do the pumping, but since the erection of the mill have only kept one man to attend to the train and mill. The mill does all the pumping for the Station now.

Yours truly, C. F. ALLEN, Supt. of wood work & car rep's.

I hereby certify that the above statement is correct.

C. G. HAMMOND, Gen. Supt.

OFFICE OF RACINE & MISS. R. R. Co, Racine, Jan. 28, 1858.

To U. S. WIND ENGINE & PUMP Co,—Your Wind Engine has ~~worked admirably ever since it was erected, [illegible]~~ ning with quite light winds; with reservoir room adapted to the consumption, there need be no expense for men at water stations.

Truly yours, ROB'T HARRIS, Sup't.

OFFICE OF THE ILLINOIS R. R. Co., Chicago, Jan. 8, 1856.

GENTS.—I employed your agent to put up one of your Wind Mills at Calumet Water Station on this road last fall. Its operation has given entire satisfaction, and much exceeded my expectations. It has not been one dollar's expense to us since it was put up. As soon as the weather moderates I shall put up one a size larger at another station. I feel fully persuaded that it will be greatly to the interest of railroad companies to adopt them generally for pumping their water. Yours truly,

R. B. MASON, Chief Eng.

OFFICE OF TERRE HAUTE, ALTON & ST. LOUIS R. R. Co.,
St. Louis, July 31, 1858.

You may deliver to us at Mattoon, one No. 8, one No. 7, one No. 6, and two No. 5 "Halladay's Patent Wind Mills and Curtis' Pumps."

Yours, very truly, JAMES A. RAYNER, Vice Prest.

MICHIGAN CENTRAL R. R. Co., July 24, 1858.

This is to certify that we have in use at Porter Station, "Halladay's Patent Wind Mill"; and for the short trial of three months I most cheerfully say, that it gives the best of satisfaction. I think it one of the best machines now in use for raising water at stations for railroad use.

Yours respectfully, S. R. JOHNSON, Road Master 2d Div.

CHICAGO, ILL., August 23, 1858.

The subscriber takes pleasure in stating that he has used two of "Halladay's Patent Wind Mills" in the Lake Shore Stock Yards, for the past two years, with entire success, and would not be without them for five times their cost. JOHN B. SHERMAN.

OFFICE OF SUPT. OF PUBLIC WORKS, CITY OF CHICAGO, Aug. 2, 1858.

JOHN BURNHAM, AGENT,—Dear sir, in reply to your favor of recent date, in relation to the working of "Halladay's Wind Mill," erected by you at the City Reform School, I would state that it has operated to my entire satisfaction. The arrangement by which it is self adjusting, works perfectly, and at the same time is so simple, it cannot easily get out of order. I considered it a doubtful experiment; but its perfect performance of its work is a sufficient answer to all objection.

Respectfully yours, N. S. BURTON, Sup't. Public Works.

DIXON, LEE CO., ILL., Dec. 13, 1856.

JOHN BURNHAM, AGENT,—Dear Sir, the Wind Mill proves fully equal to your recommend, and I suppose I must pay for it. Please acknowledge the receipt of the enclosed draft, which balances your claim. Several of my neighbors say if my mill works as well this winter as it has up to this time, they shall order mills next season. I consider my farm worth five hundred dollars more to day than I did before the mill was put in. My water being forty feet below the surface in the solid rock, made it a complete drudgery to pump all the water by hand. Before I heard of Halladay's Mill, I had serious thoughts of selling out on this very account.

Yours truly, J. H. PAGE,

From E. More, Esq., Proprietor of the Eagle Hotel, Chicago.

CHICAGO, Jan. 25, 1858.

One of "Halladay's Wind Mills," was erected on my farm, in Dunton, Ill., in the fall of 1856, and is now operating in the most satisfactory manner forcing water through a half inch lead pipe more than one half mile to my house and barn, in quantity sufficient to supply more than 200 head of cattle. I consider my farm worth more than one thousand dollars more in consequence of this improvement. Truly yours, E. MORE.

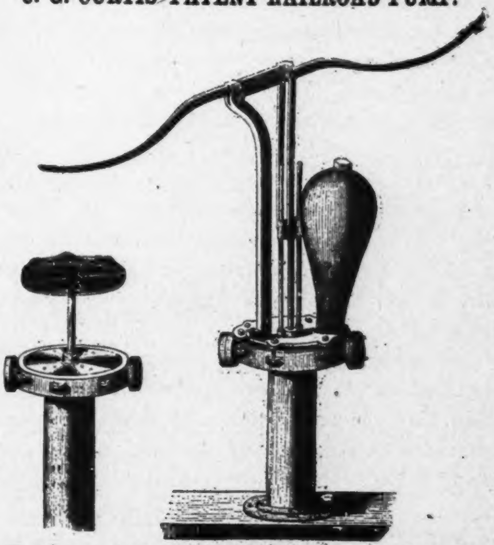
COTTAGE GROVE, Dane Co., Wis., Jan, 1858.

D. J. POWERS, ESQ.,—*Dear Sir:*—Yours, requesting information respecting the working of Halladay's Wind Mill, as being tested on my farm, was duly received. In the ordinary way, by hand pumping, four families with their stock have been supplied with water from my well for six years. I had one of Hallady's Mills put in successful operation in the spring of 1857, which elevated a stream of pure, cool water from the well, which is 84 feet deep, in sufficient quantity to supply all our wants, to my great joy and profit. Our families have thus been relieved from a vast amount of hard work, and our stock have had a supply of fresh water. The mill has kept at work finely, with the exception of some trouble caused by the bursting of a flawy piece of pipe, which being remedied, the mill has continued to work to my satisfaction. I think that these mills will prove of almost inestimable value to this western country, where the most serious difficulty we have to contend with is a lack of fresh running water. JOHN G. KANOUSE.

"The Mill works admirably, and is always on hand. The reservoir is near the Mill, and is 10 by 18 feet inside, by 3 1-2 feet deep. The mill was started in the evening and the next morning the reservoir was full and the mill standing still, the wind blowing with considerable force. A stock of some 90 head of horses and cattle and some 450 sheep, also other farm and house uses, have been supplied from from this resovoir, it being almost constantly full. As soon as the water was being drawn, the mill would start and run till full again, and then stop until water was again drawn, and so continue. So far nothing has been out of order about the mill, it is always on hand when the wind blows, and nothing has supprised me more than the small amount of wind it required to run it. Nor does it run only at a moderate speed; let the wind blow as it will, it is under such perfect control. I cannot well place a value upon such a convenience; suffice it to say, I would not do without it. It must work a great change in our State, especially in stock farms; the necessity to locate near streams of water, where there is more or less waste land, will be done away with; as water can be obtained often in more convenient locations.

Yours truly, ROBERT ROWE, Newark, Ill.

C. G. CURTIS' PATENT RAILROAD PUMP.



The important advantages of this pump, are: the valves are all arranged on *one* circular plate, surrounding the cylinder on the top of the pump. By opening *one* joint only, as seen in cut, and raising the cap, free access is had to all the valves and plunger. It will therefore readily be seen that common mechanics can easily renew the valves and packing on the plunger, without disturbing the foudation fastenings, or disconnecting the supply or discharge pipes, which are both flanged on to either side of the upper end of the pump, just below the valve plate. The above described improvements, together with the great strength and durability of all parts of the pump, renders it a striking improvement over everything of the kind ever before offered to the public.

OFFICE ILLINOIS CENTRAL R. R. Co, Chicago, March 8, 1856.

Halladay Wind Mill Company:—Gentlemen,—I am confident railroad managers generally, will agree with me when I say, there is no one thing connected with our business that has given us more trouble than in obtaing durable perfect operating hydraulic machinery, which would be easily kept in good working order by our common workmen. For several years past I have endeavored to secure the best pumps made in this country, trying every new invention that has been offered, which gave evidence of merit. It is with much pleasure therefore, that I inform you that the pumps you furnished me have given much better satisfation than anything we have ever tried on this road. The simplicity and durability of your pump must commend it to the favorable notice of railroad men, and cause it to generally adopted when its merits are understood. Yours truly,

R. B. MASON, Chief Engineer Ill. C. R. R. Co.

Reverse Side of Circular, Shown On Opposite Page.

CONCRETE DEPARTMENT

Cinder Concrete.

CINDER concrete has been used a great deal in the past and is being used to considerable extent at present to protect structural steel from rust, and as fireproofing. It has always been an open question, however, whether cinder concrete really is a protector or a corrosive agent.

The sulphur in steam cinders has in general been cited as the element which causes corrosion of steel embedded in cinder concrete. It is a fact, notwithstanding this impression, that as a general rule cinders produced by well burned hard coal contain very little sulphur; the same is not always true of soft coal cinders, however. In this case, even if all the sulphur content was oxidized to sulphuric acid, it would in all probability be neutralized by the strong alkaline content of cement and rendered harmless as far as the steel is concerned.

Although great quantities of steel have been rusted and partially destroyed when "protected" by cinder concrete, the reason in general has been poor material with large, porous, friable and hollow lumps therein. These lumps absorb a great deal of moisture and even if water in corresponding amounts to that used for stone concrete mixtures is used, the resulting mixture is in truth quite dry, on account of the absorption of water by the lumps of cinder. The result is a porous concrete full of voids, and consequently incapable of protecting steel from rust, since it lacks the prime requisite, that of being an air excluder. In such mixtures the steel is not covered with cement, and the iron oxide often found in cinders causes the rusting of steel with which it comes in contact. It has also been found by experiment that cinders exposed to weathering and washing have the ferrous iron and sulphate content leached out, and the concrete made from these cinders is not so porous and is less liable to disintegrate.

With these facts in mind it appears that where cinder concrete is used to protect structural steel on account of its relatively light weight, and not to carry loads, the following specification will aid in producing good cinder concrete.

1. Coat all steel to be in contact with cinder concrete, with Portland cement grout.

2. Use only best quality of steam boiler, hard coal cinders, crushed to pass a 1-inch mesh, and freed from ash and foreign matter. Wash all cinders thoroughly and use only those which have been stored and exposed to weather for some time, if possible.

3. The mixture employed should not contain too great an amount of cinders. The proper proportions of cement, sand and cinders would be those which by test give the densest mixture.

4. Water in amounts necessary to produce a very wet mixture should be used.

5. The time required for mixing should be somewhat longer than for stone concrete in order that a uniform mixture be acquired.

6. In placing, remove all light, floating particles of cinder which if left in concrete produce a porous surface.

7. Cover all cinder concrete with a coat of cement mortar, ½ in. to 1 in. in thickness, or with some waterproofing material, as an extra precaution toward preventing admission of air into concrete.

8. Have an inspector who knows his business on the work at all times, to see that the specifications are fulfilled, for without rigid inspection specifications are practically worthless.

The effect upon steel of the presence of sulphur in aggregates is one of the subjects now under consideration by the Committee on Tests of British Concrete Institute. This investigation will no doubt be held with particular reference to sulphur in cinder concrete and the results will be of int rest to all railway engineers.

Specifications for Portland Cement, D. L. & W. R. R.

IN our August (1912) issue we published an editorial on the adoption of the Force Autoclave test of Portland cement by the Delaware, Lackawanna & Western R. R. In this issue we are publishing in full the new specifications issued Jan. 1, 1913, by this company. Without doubt these are the most rigid specifications ever issued in this country, but we believe it is for the good of the industry.

The points on which these specifications differ from those of the American Society for Testing Materials of 1908, (called standard) are as follows:

Fineness.—The new specifications demand that 95 per cent by weight shall pass a No. 100 sieve and 80 per cent a No. 200 sieve; the standard specifications require only 92 per cent and 75 per cent to pass the No. 100 and No. 200 mesh sieves respectfully.

Initial Set.—The initial set shall not be acquired in less than 1 hour as against 30 minutes for standard specifications.

Soundness.—The constancy of volume requirements of the standard specifications are very far from being as severe as the autoclave test required by the D. L. & W. R. R., this latter test being substituted for the normal and accelerated constancy of volume tests because of the failure to detect poor cement in many cases when these tests were used.

Tensile Strength.—The Lackawanna specifications demand a tensile strength of 200 lbs. for neat cement briquettes stored in moist air for 24 hours as against 175 lbs. per sq. in. required by the standard specifications. The 7 and 28 day requirements are the same in both cases. For 1:3 mixtures the new requirement is 250 lbs. for 7 day tests and 375 lbs. for 28 day tests, or 50 and 100 lbs. per sq. in. more, respectively, than the standard requirement.

It would not be surprising if some or even all of these more rigid requirements should be adopted as standard by the American Society for Testing Materials in the near future. The D. L. & W. R. R. is using a great deal of cement in the relocation of old lines and the rebuilding of new, and since this work is of the highest type of permanent construction, the engineer of tests, H. J. Force, has adopted this specification (after making numerous tests), in order to insure that the cement used will be of such a character as to make the structures permanent.

Concrete Practice No. 6, Kansas City Southern Ry. Co.

A. M. Wolf.

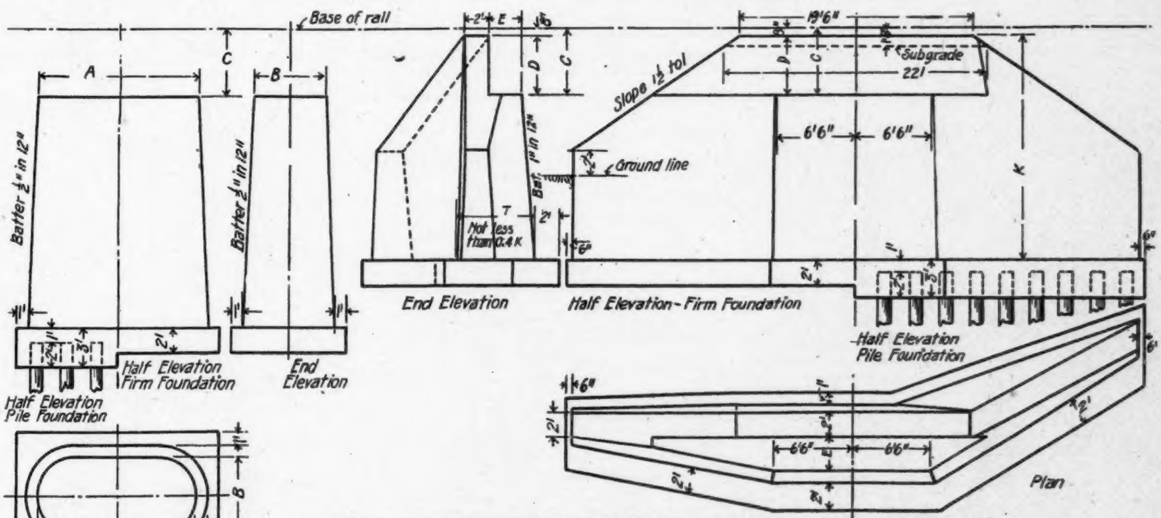
The Kansas City Southern Ry. uses plain and reinforced concrete structures wherever practicable and we are describing and illustrating herein such structures as have been adopted as standard.

Plain Concrete Abutments and Piers.

The standard sheets for plain concrete abutments (straight and wing) and piers for deck and through girder single track spans are shown here. The tables give the dimensions of the various parts for the different spans.

The concrete mixture for both abutments and piers is a 1:3:5 mix, with either stone or gravel as the coarse aggregate. The footings of abutments are made 2 ft. thick on firm soil and 3 ft. thick where piles are used, the piles projecting 2 ft. into the footing, piles to be spaced not more than 2 ft. 6 in. centers. Footings project 2 ft. at the face of abutment and 1 ft. at the back. The carried down vertical to footings at points where the surface of ground is 2 ft. below top of wing. Bridge seats are from 2 ft. 9 ins. to 3 ft. 3 ins. wide. No copings are used but all exposed edges are rounded to a 1 in. radius. Expansion joints between wings and abutment are used in special cases only. The distances "F," "C" and "H" given in tables apply to structures on tangent and due allowance is made on curves. Masonry plates on bridge seats are set 3 in. from face of backwall for 30 ft., 40 ft. and 50 ft. spans, and girder pedestals are set 2¾ in. from backwall for 60 ft. spans.

The abutments are designed for earth pressure in accordance with Rankine's formula with an angle of repose of 33 degrees and 42 min. for earth and a live load taken equivalent to a surcharge of 5 ft. No "U" or "T" abutments of concrete are used.



Size Span	A Width of Pier	B Thickness of Pier	C Dist. from B. of R. to br. seat.	D Dist. from top of backwall to br. st.	E Width of bridge seat	F Dist. betwn faces of backwalls	G Dist. from ℄ Pier to face of backwall	H Distance between ℄s of piers	Size of Masonry plates.
30'	12'	5'	5'5"	4'9"	2'9"	30'6"	30'4½"	30'8"	1'8"x1'10"
40'	13'	5'	5'11"	5'3"	2'9"	40'6"	40'4½"	40'3"	1'8"x1'9"
50'	14'	5'6"	6'11"	6'3"	2'9"	50'6"	50'4½"	50'3"	1'9"x2'0½"
60'	15'	6'6"	8'7¼"	7'11¼"	3'	60'8"	60'7½"	60'7"	2'x2'6"

Plain Concrete Pier and Abutments for Deck Girder Spans, K. C. S. Ry.

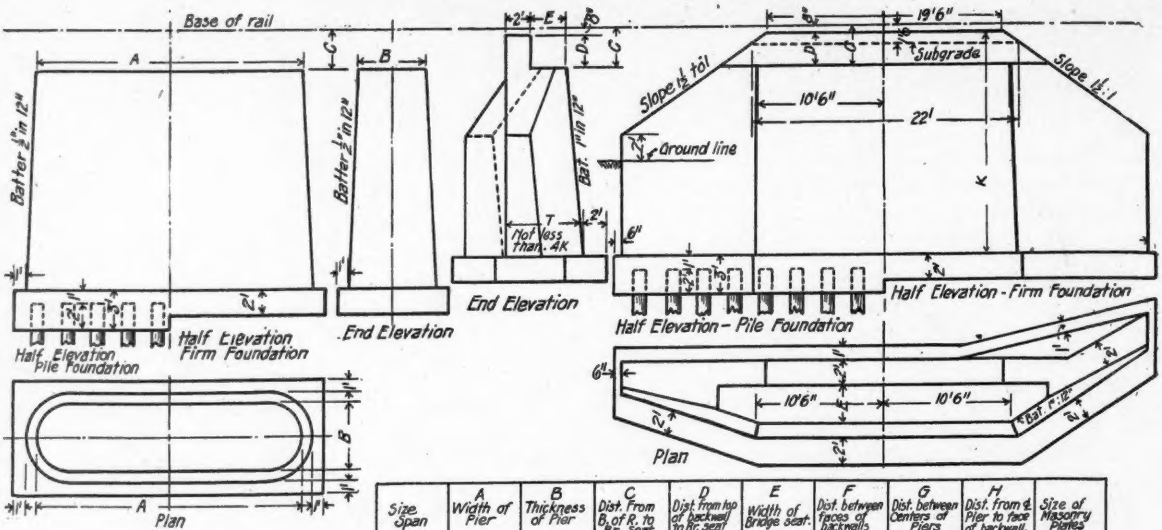
batter of face of abutments is 1 in. in 1 ft. and that of back is made such as to suit conditions, the thickness at the footing to be not less than 0.4 the height of the abutment above footing. The top of backwall which is made 2 ft. wide, is located 8 ins. below base of rail. The face of backwall is vertical and the back is vertical for through girder span abutments and battered for deck spans so that the width at the bridge seat is 0.4 the height. For deck girder spans the height of backwall is varied from 4 ft. 9 ins. for 30 ft. span to 7 ft. 11¼ ins. for 60 ft. span. For through spans this height varies from 9 ins. to 2 ft. 8½ ins. for the same spans. The length of backwall is made 19 ft. 6 ins. for both types. The face of abutment is made 13 ft. wide for deck girder spans and 21 ft. wide for through girder spans.

The wing walls have same batter as main part of abutment and have a top slope of 1½ to 1. Flared wing walls are used where local conditions demand and the angle of wing is made such as to best suit the conditions. The top and end widths of wings are made 2 ft. Wings are

Piers have face batters of ½ inch in 1 ft. and the ends are circular. The footings of the same depths as for abutments, project 1 ft. beyond base at the sides and ends. The thickness of piers varies from 5 ft. to 6 ft. 9 in. for 30 to 60 ft. spans. The width of piers for deck girder spans varies from 12 ft. for 30 ft. spans to 15 ft. for 60 ft. spans. For through girder spans the widths vary from 21 ft. 6 in. to 25 ft. 9 in. for the same spans. Masonry plates are spaced 3 in. apart on piers for spans up to 60 ft. and pedestals 2½ in. apart for 60 ft. spans. No reinforced concrete piers are used by this railroad.

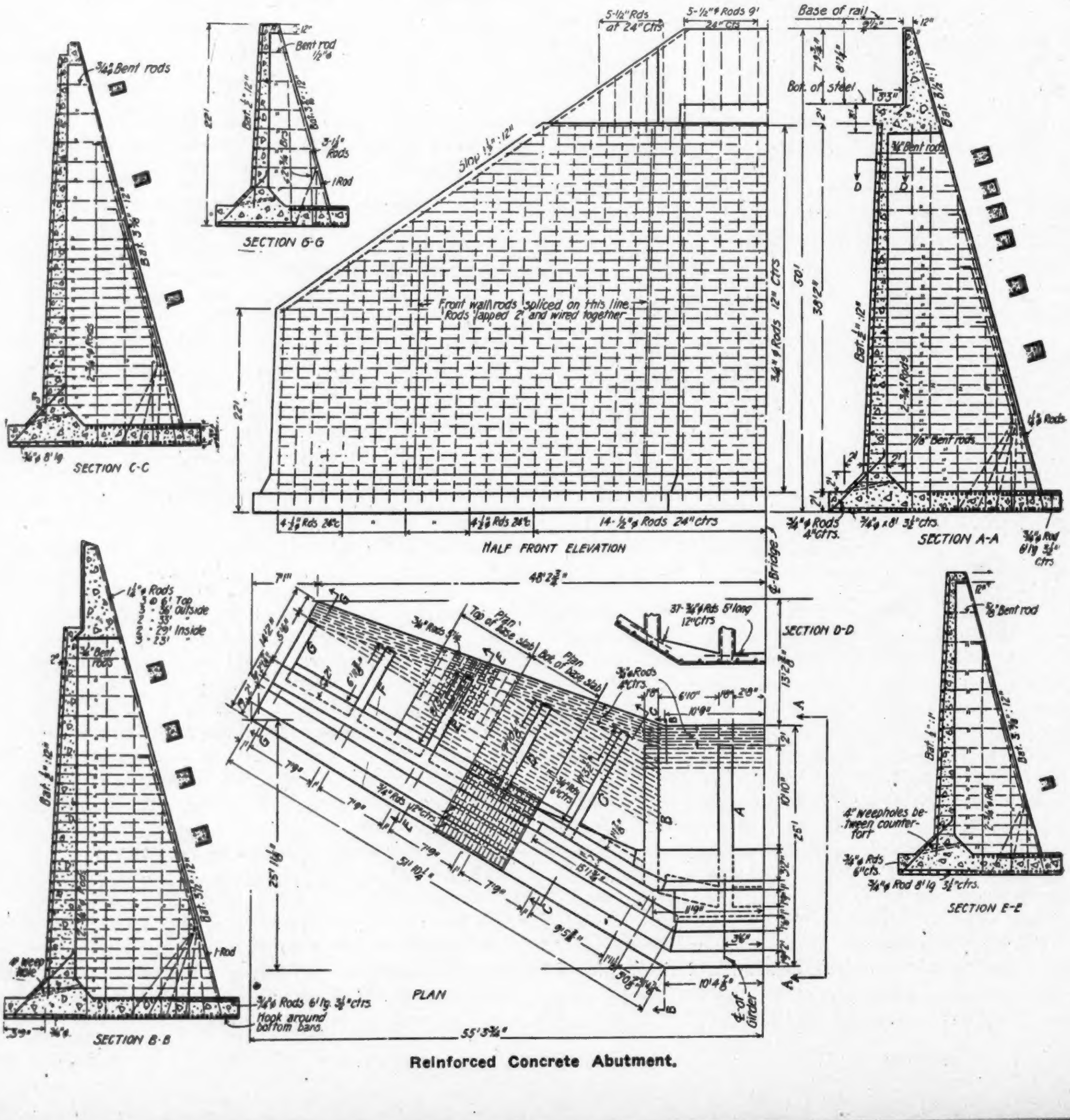
Reinforced Concrete Wing Abutment.

Although it has long since been shown by experience that the saving effected by using reinforced concrete for abutments instead of plain concrete, is very great, amounting in some cases to 35 or 40 per cent, the use of reinforced concrete abutments has not been very extensive. However, we venture to say that the time is not far distant when economic principles will be more closely considered and reinforced



Size Span	A Width of Pier	B Thickness of Pier	C Dist. From B. of R. to Br. Seat.	D Dist. from top of backwall to Br. seat	E Width of Bridge seat.	F Dist. between faces of backwalls	G Dist. between Centers of Piers	H Dist. from ℄ Pier to face of backwall.	Size of Masonry Plates
30'	21'6"	5'	1'5"	0'9"	2'9"	30'6"	30'3"	30'4½"	1'9"x1'10"
40'	22'	5'6"	3'2"	2'6"	3'	40'6"	40'3"	40'4½"	1'6"x2'
50'	22'	5'6"	2'7½"	1'11½"	3'3"	50'6"	50'3"	50'4½"	1'9"x2'3"
60'	25'9"	6'9"	3'4½"	2'8½"	3'3"	60'6"	60'3"	60'4½"	1'11½"x2'4½"

Plain Concrete Pier and Abutment for Through Girder Spans.



Reinforced Concrete Abutment.

concrete abutments will be used extensively, especially for comparatively high abutments.

The abutment illustrated and described here is an unusually large one, having a total height of 50 ft. from bottom of footing to the top of the back wall. The concrete used was of a 1:2:4 mixture, the stone to pass through a 1-in. diameter ring.

A shallow footing of reinforced concrete 2 ft. thick and 25 ft. wide (equal to one-half the height) is used for the base of the abutment. The width of footing of wings narrows down to 14 ft. 2 in. at the end where the height of wing is 22 ft. The footing is reinforced longitudinally in bottom of the slab, with ¾ diameter bars at 4 in. spacing in the heel between edge and base of counterforts, 6 in. spacing from that point to center line of face wall and 12 in. spacing for bars in the toe of footing. The transverse bars in bottom of the footing are ¾ in. diameter, 8 ft. long with a spacing of 3½ inch centers, these bars extend from the toe back into base under the face wall and wings. Longitudinal bars ¾ inch in diameter in the top of footing slab are spaced 12-in. centers continuously, with ¾ in. dia. bars 5 ft. long, 12 in. centers staggering with long bars at counterforts, these bars are placed in that part of the slab back of face wall only. Transverse bars ¾ in. in top are 6 ft. long with 3½ in. spacing, extending from heel into the base. The footing projects 3 ft. 9 in. beyond face of abutment. All continuous bars are lapped 24 in. and wired together at splices. Bars are placed with centers 3 in. from concrete faces.

The batter of the abutment face and wings is ½ inch in 1 ft., while the back of wall is vertical. The top thickness of face wall under bridge seat is 1 ft., while the base thickness is 2 ft. 6 in. The face wall is connected to the base with a continuous 2 ft., 45 degree fillet at face and back with ¾ in. dia. bars at 45 degrees in face of fillet between wall and base. The face wall and wings are reinforced near face with ½ in. diameter bars 24 in. centers vertical and ¾ in. bars 10 in. centers horizontal, lapped 2 ft. at splices. The vertical bars in wings are made in four lengths on account of 1½ to 1 slope of top of wings, so as not to have all bars of different lengths. This leaves triangular portions at the top unreinforced vertically, but these areas are small and the omission is to be recommended from a practical standpoint. The wings have a top width of 1 ft. below coping which is 1 ft. thick and 2 ft. 1⅞ in. wide, flush with face. Extra reinforcement is placed horizontal at back of wall at junction of counterforts with face wall, these bars are ¾ in. dia. 5 ft. long, spaced 12 in. centers.

The counterforts of sizes and dimensions shown on plans are reinforced with ¾ in. bars horizontal, bent around the slanting bars in back of counterforts in the form of hairpin rods. The vertical bars are placed in pairs, spaced as shown on details of counterforts. The main slanting bars, 1¼ in. dia. in back of counterforts fan out near the base and are hooked around the longitudinal bars in the footings. These details are clearly shown in elevations of the counterforts. The back batters of the counterfort are 3½ in. and 3⅜ in. in 1 ft. Some of the bars in the back of counterforts extend up into the back wall which has the same back batter and a top thickness of 1 ft., a vertical face and a height of 7 ft. 7¾ in. Bars ½ in. are placed 24 in. centers, in face of back wall.

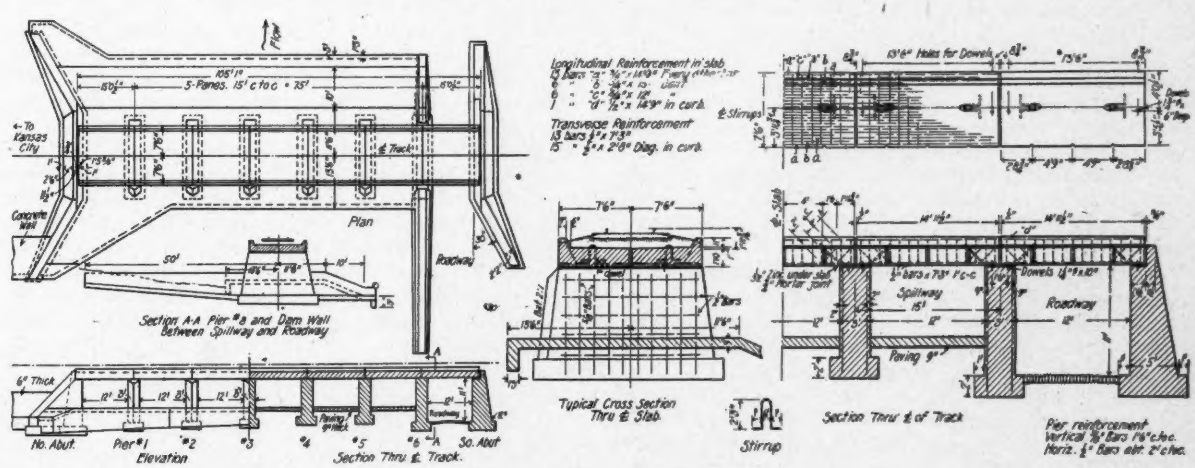
The bridge seat is 3 ft. 3 in. wide, 3 ft. thick and unreinforced. A 2 ft. coping with 6 in. projection is used at the bridge seat. The center line of bearing on the bridge seat is 1 ft. 5 in. from the face of back wall or 2 in. behind the line of the back of face wall.

The loads assumed as acting on the abuntment from the girder span were: Dead load=56,000 lbs; live load, 266,000 lbs.; impact at 70 per cent=178,000 lbs., or a total of 500,000 lbs. The surcharge assumed for parapet was four feet and that for base two feet. Earth assumed to weigh 100 lbs. per cubic foot. The formulae recommended by the Amer. Ry. Engrg. Assoc. in Bulletin No. 108 were used in design. The unit stress in the steel was assumed as 15,000 lbs. per square inch tension, and a stress of 600 lbs. per sq. inch compression in the concrete.

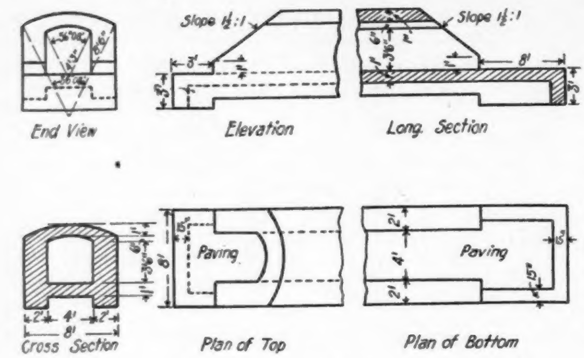
The following extract from the specifications regarding reinforcement is of interest:

"All bars to be of medium steel of the deformed type (corrugated rounds used). The reinforcement in the finished structure shall accurately conform in size and position to the requirement of plans. All reinforcements shall be free from rust, scale or coating of any kind tending to reduce the bond. All reinforcing bars shall be bent cold in a bending machine, to the dimensions and forms shown on plans before they are placed in position."

"All reinforcing bars shall be placed and held during construction accurately in position shown on plans. They shall be firmly bound and tied together by wire where they lap or cross; or be fastened by clips and other devices where specially called for. Adjustment of bars during the depositing of concrete will not be permitted. Where necessary small blocks made of cement mortar may be used to support the reinforcing rods at proper distance from the forms."



Reinforced Concrete Slab Bridge.



Plain Concrete Box Culvert.

The structure illustrated and described is a reinforced concrete slab bridge over a pond spillway and highway. The slabs were cast in yard and hauled to site and set in place.

The abutments are of the standard plain concrete type previously described. The piers, of a semi-reinforced design are 3 ft. thick with a footing 5 ft. wide and 2 ft. deep, top width of piers is 15 ft. The sides are vertical and the ends are battered 2 in. to 1 ft. with a 45 degree starkwater at upstream end. The pier reinforcement consists of ⅝ in. bars 18 in. centers vertical extending into the footings and ½ inch bars 2 ft. centers horizontal near both faces. Piers and abutments and spillway are of 1:3:5 concrete.

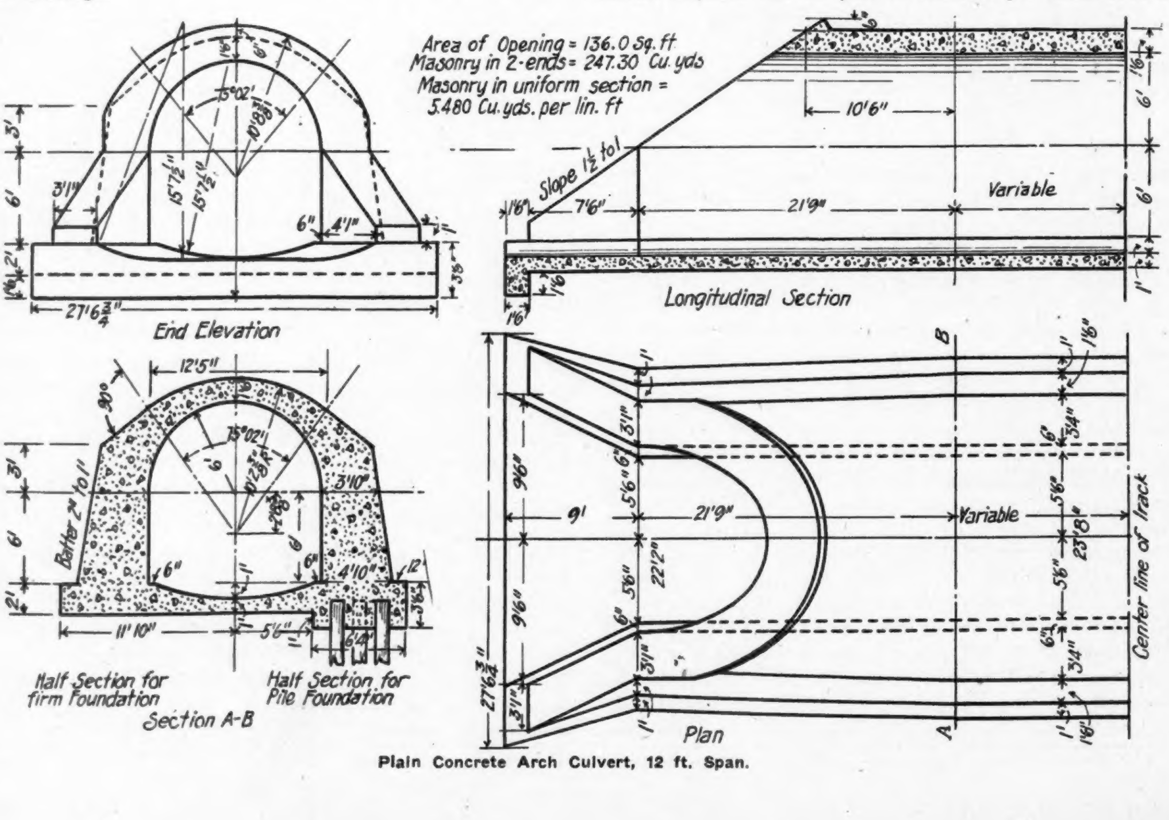
The spillway between piers is a 9 in. plain concrete slab with end baffle walls 3 ft. deep and 15 in. thick.

The deck slabs of 1:2:4 concrete are 14 ft. 11½ in. long for 15 ft. c. to c. span and 7 ft. 6 in. wide, two slabs being used for each span with a longitudinal joint at the center line of track. The slabs are 1 ft. 11 in. thick at the parapets, which are 11 in. high and 9 in. wide on top, and 1 ft. 10 in. thick at the center line of track. V-shaped grooves in inside edges of slabs, three in each span, form 1 in. square holes for drainage.

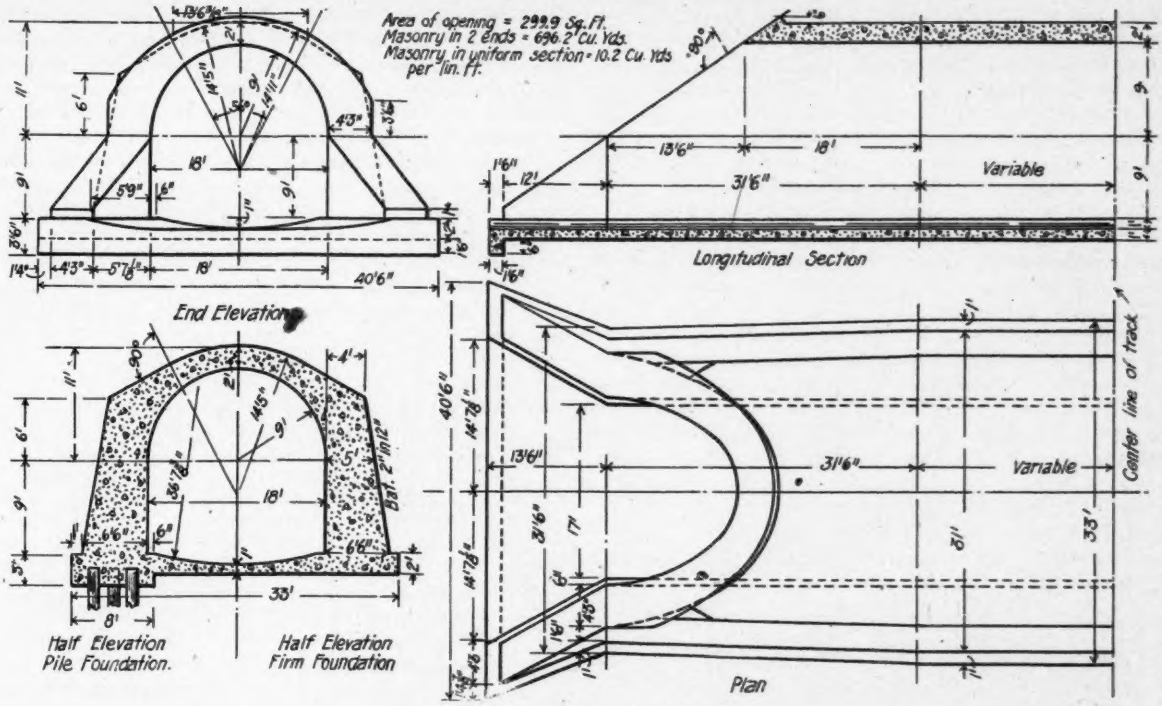
The main reinforcement consists of ¾ in. square bars 3½ in. centers longitudinally, every other bar being straight and the others bent up to form shear reinforcement at the supports. The transverse or distributing bars are ½ in. squares 7 ft. 3 in. long, 12 in. centers with ½ in. bars 2 ft. 8 in. long, 12 in. centers bent into curb or parapet. The curb is reinforced longitudinally with one ½ in. bar 3 in. from side and top. Handling stirrups of ½ in. diameter are placed at both ends of slab at an angle of 45 degrees, to facilitate handling. The slabs are anchored to piers by a 1¼ in. diameter dowel 10 in. long at each end projecting 5 in. into slabs. The tops of piers and seats on abutments are built up to within ¾ in. of the bottom line of slabs. This space is filled with a mortar joint covered by a zinc plate 1/32 in. thick when placing slab. All exposed surfaces are neatly finished and exposed corners are rounded to a 2 in. radius. The deck is painted with 3 coats of coal tar paint, one gallon to cover 40 sq. ft. The reinforcing bars are of medium open hearth steel, of the deformed type. The forces assumed in design are dead load of slab, ballast and track and a Cooper's E-60 live load with 25 per cent impact. The allowable tension in steel being 14,000 lbs. per sq. in. and the compression in the concrete 600 lbs. per sq. in. in cross-bending.

Plain Concrete Box Culverts.

Some plain concrete box culverts are used for small drainage openings. The one described here is a 4 ft. x 4 ft. box section built of 1:3:5 concrete with an arched slab of 1 ft. thickness, sidewalls 2 ft. thick and a floor slab 1 ft. thick. The floor slab is omitted where the foundation is solid rock. The footings of bench walls extend 1 ft. below bottom of paving for a good foundation with same thickness as walls, but where a good foundation cannot be obtained with standard form of culvert, the footings are extended 1 ft. outside of walls and to the depth required. The ends of the culvert are cut-off at a slope of 1½ to 1 and the paving extends beyond the barrel of culvert as shown with 15 in. baffle walls carried down 3 ft. at sides and ends. This culvert requires 1.26 cu. yds. of concrete per lineal foot of



Plain Concrete Arch Culvert, 12 ft. Span.



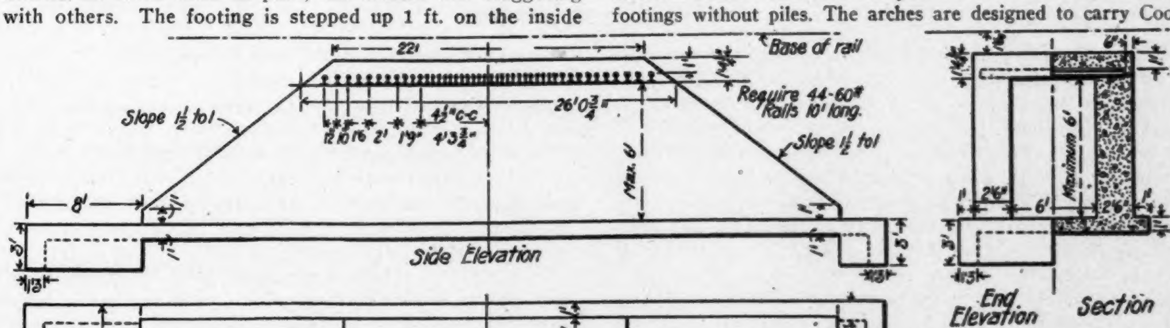
Plain Concrete Arch Culvert, 18 ft. Span.

uniform section and 17.2 cu. yds. for the two ends, based on a depth of footing 1 ft. below bottom of pavement. This culvert was designed for standard E-60 loading distributed through fill. Double box sections of this same type are also used.

Plain Concrete Arch Culverts.

For larger openings concrete arch culverts have been adopted as standard. The standard 12 ft. culvert will be described in detail. The opening with an area of 136 sq. ft. is 12 ft. wide and 6 ft. high at edge to springing line of arch which has a 6 ft. radius. The top surface of the bottom slab is curved to a 15 ft. 7½ in. radius so that the surface is 1 ft. lower at center line. The footing is made 2 ft. thick at the edge in firm soil and projects 1 ft. beyond the back of side walls. Where the foundation is poor, the thickness of footing is increased or a pile foundation is used or in some cases both. In ordinary cases where piles are used the footing is made 6 ft. 4 in. wide and 3 ft. 6 in. deep carried on three rows of piles, the middle row staggering with others. The footing is stepped up 1 ft. on the inside so that the bottom slab is of same thickness as when piles are not used. Where sidewalls reach rock, the footings and paving are omitted. The side walls at middle portion are 3 ft. 10 in. thick at the springing line and 4 ft. 10 in. thick at a point 21 ft. 9 in. from end, the wall thickness decreasing gradually toward ends where they are 9 in. less in thickness at the footing; back batter is 2 in. to 1 ft. The back slope is carried up 3 ft. above springing to meet the curve of extrados of arch which has a radius of 10 ft. 2⅜ in. The arch ring is 18 in. thick at the crown. The ends of culvert are cut off even with a 1½ to 1 slope from crown of roadbed. At the end of arch ring a parapet 6 in. high is formed.

The wing walls are 3 ft. 1 in. wide at the top and 7 ft. 6 in. long measured on the axis of arch, and have a flare of 4 ft. and a height of 1 ft. at the end. The footing and paving is carried out 1 ft. 6 in. beyond end of wings and terminates in a baffle wall 1 ft. 6 in. thick and 3 ft. 6 in. deep. This culvert requires 5.5 cu. yds. of concrete per lineal foot of uniform section and 247.3 cu. yds. in the two ends, based on footings without piles. The arches are designed to carry Coop-



Standard Rail Top Culvert.

er's E-60 live load with 40 per cent impact, when the distance from crown of fill to top of culvert is 24 in.

The details of an 18 ft. plain concrete arch culvert are also shown. This culvert is designed on the same basis as the one just described. The 18 ft. culvert contains 10.2 cu. yds. of concrete per lineal foot of uniform section and 696 cu. yds. in the two ends based on culvert with 2 ft. footings. The area of opening of this arch is 300 sq. ft. The concrete used in these culverts is of a 1:3:5 mix.

Standard Rail Top Culvert.

A standard 6 ft. concrete culvert with rail top designed for a 22 ft. roadway is shown herewith.

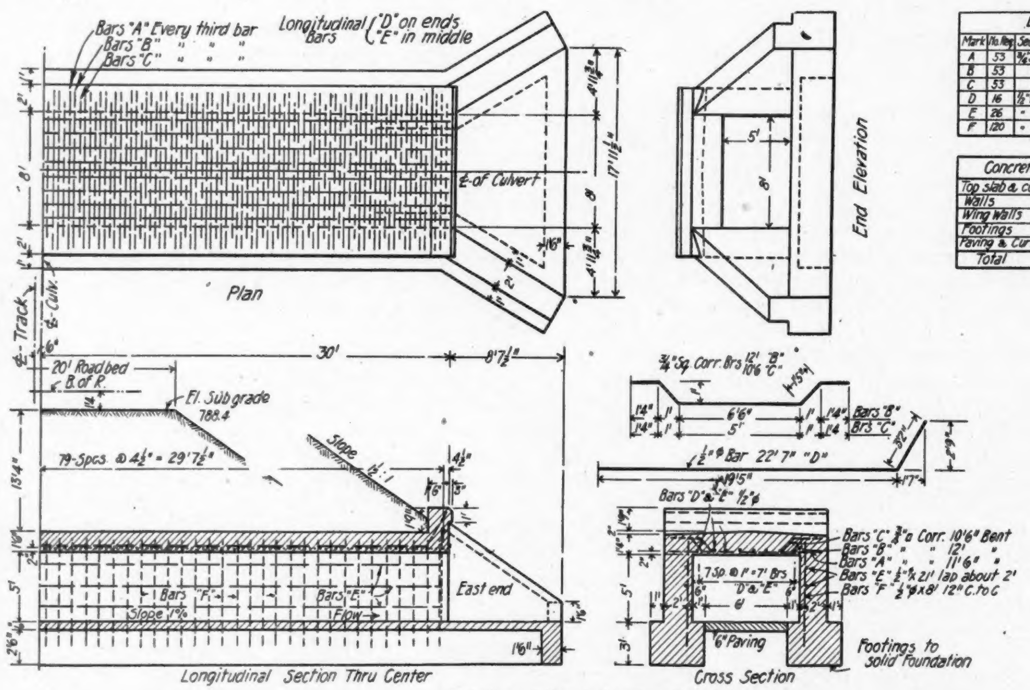
The cover slab is 1 ft. 4¼ in. thick or 1 ft. above top of rails, the bottoms of which are not covered with concrete. The rails which are used weigh 60 lbs. per yard and they are made 4 ft. longer than the opening. For a distance of 4 ft. 3¾ in. each side of the center line of track they are spaced as close together as possible beyond these points the spacing is increased as shown in the details. The bottoms of rails which are exposed are given two coats of standard bridge paint after completion of culvert. The concrete for the cover slab is made a 1:2:4 mix while that for remainder of structure is a 1:3:5 mixture.

The side walls are of plain concrete 2 ft. 6 in. thick, the ends being cut off at a slope of 1½ to one from points 11 ft. from center line of culvert. The footing slab 1 ft. thick projects 1 ft. beyond outside face of side walls and extends out 3 ft. beyond end of walls at the upstream end and 8 ft. at the downstream end of culvert to prevent scour and undermining of the structure. A baffle wall 15 in. thick and 3 ft. deep extends around edge of the projections of paving to afford additional security against scour. This type of structure is designed for same conditions of loading, as the culverts described above.

Reinforced Concrete Box Culvert.

The reinforced concrete 5 ft. x 8 ft. box culvert details of which are given is built of 1:3:5 concrete for sidewalls, wing footings, paving and curtain or baffle walls and a 1:2:4 concrete for top slab and coping. The reinforcing bars are of medium open hearth steel rolled from new billet stock and are of the corrugated type of deformed bar.

The footings, for the side walls and wings are of plain concrete 4 ft. wide and about 3 ft. deep resting on a solid foundation. A paving slab of plain concrete 6 in. thick extends out to the end of the wings where it terminates in a baffle or curtain wall 18 in. wide and of same depth as footings. The sidewalls 2 ft. thick are reinforced with ½ in. diameter vertical bars 8 ft. long 12 in. centers extending into the foundations for a depth of 2 ft. These vertical bars are placed 3 in. from inside face of walls. The horizontal reinforcement consists of three ½ in. bars 21 ft. long, 18 in. cts,, lapped about 2 ft. at splices. The top slab with an 8 ft. clear span is 1 ft. 6 in. thick at the center with a 2 in. slope toward sides. The main or transverse reinforcement consists of ¾ in. square bars 4½ in. center every third bar being straight and 11 ft. 6 in. long, the other bars are bent as shown in details (Bars B. & C.) and placed so that the bent-up portions of the bars stagger 9 in. at each end, thus affording more efficient shear and negative moment reinforcement. Longitudinal reinforcement is furnished by ½ in. diameter bars 1 ft. centers just above the transverse bars in the bottom of the slab. The ends of the bars are bent up into the parapet wall which is 1 ft. 9 in. high and 18 in. wide with a coping 1 ft. deep projecting 3 in. beyond face of parapet. The splayed wings are of plain concrete 2 ft. thick with a top slope of 1½ to 1.



Bill of Bars				
Mark	No. Req.	Section	Length	Remarks
A	53	¾" Sq. Cor.	11'6"	
B	53	"	12'	Bent See sketch
C	53	"	10'6"	"
D	16	½" ⌀	22'7"	"
E	26	" "	21'	
F	120	" "	8'	

Concrete in Box	Cu. Yds.
Top slab & coping 1:2:4 Mix.	40.4
Walls 1:3:5 "	44.4
Wing Walls " "	11.2
Footings " "	69.3
Paving & Curtains " "	13.9
Total	179.2

Reinforced Concrete Box Culvert.

All exposed surfaces of the culvert are neatly finished and all exposed corners rounded to a 2 in. radius. The top and outer surfaces of walls are covered with an approved waterproof coating. Culverts are not put into service until 30 days after completion.

This type of culvert is designed for Coopers E-60 live load plus an impact percentage of a variable amount, which is 40 per cent when slab is at subgrade and zero when the fill is 10 ft. or more in depth. The dead load is assumed equal to weight of fill on top plus weight of slab. The reinforcement is designed for a tensile stress of 14,000 lbs. per square inch. The compression in concrete, allowable, being 600 lbs. per square inch in crossbending.

Comment.

This company does not use reinforced concrete piers, arches, viaducts or trestles; neither are reinforced concrete

slab floors for steel bridges used. A noticeable point in the practice of this road is the cutting off of the culvert barrels at a slope parallel to that of fill and thereby doing away with wing walls. This type of culvert is said to be more economical than one with wings and much easier to build. We are indebted to Mr. C. E. Johnston, Chief Engineer, for plans and data from which this article was prepared.

New Books

AMERICAN CIVIL ENGINEERS' POCKET BOOK—By Mansfield Merriman. Second edition enlarged, 4½x7; morocco; 1,483 pages; 500 tables, 1,200 cuts. Published by John Wiley & Sons, New York City. Price $5.00.

The second edition of this new handbook, and the popularity of which is demonstrated by its being in its fifteenth thousand, is much more complete and more nearly correct as regards typography than the first edition, issued in December, 1910. The general arrangement of the book, in sections edited by associate editors, men recognized as authorities in their respective lines, is preserved, and two new sections have been added. Even with careful revision there still remains some overlapping of text, some data which should be brought up to date, and a number of typographical errors.

Section 1 consists of 40 pages of mathematical tables by Mansfield Merriman. The next section, of 112 pages, by Charles B. Breed, treats of surveying, geodesy, and railroad location. A considerable share is devoted to location work and earthwork computations, much of this latter being new in this edition. The subject of haul and the mass diagram is treated in a very clear and concise manner.

Section 3, steam and electric railroads, by Walter Young Webb, has been revised to the exclusion of roads (treated in a new section), and now contains 120 pages of excellent material on traction, roadway drainage, track and equipment. Many of the recommendations of the American Railway Engineering Association (the name of the association has not been changed in the new edition), are incorporated in the text, making it very complete and authoritative. Considerable cost data is given, which should prove of value to the location and valuation engineer. The portion of this section treating of electric railway construction and equipment is replete with tables, diagrams and data pertaining to electric traction.

Materials of construction, by Rudolph P. Miller and three associates, is a large section treating of mechanics of simple stresses, beams and columns, testing and inspection, with tables of properties of structural shapes, etc., similar to those found in standard handbooks.

Section 5, plain and reinforced concrete, by Frederick E. Turneaure, remains unchanged in this new edition. The general portion of this section is very thorough to the exclusion of a more extensive and detailed treatment of design and construction of reinforced concrete structures. The text on theory of design is entirely too brief, and the same may be said of that on forms for concrete work, which is so general as to be somewhat out of place. The subject of "flat-slab" floors for buildings is omitted entirely. This stamps this section as being somewhat out of date, when one considers that a major portion of reinforced concrete buildings built today are of the flat-slab type. It appears that some time could have profitably been spent in revising and making this part of the book more complete

The subject of masonry, foundations and earthwork as related to building construction, is treated in a very thorough manner by Ira O. Baker. In Section 7 Walter J. Douglas has compiled much valuable data on the design and construction of masonry and timber structures, such as retaining walls, dams, arches, timber trestles and falsework for bridges. The indiscriminate use of subscripts in the article on retaining walls, is rather confusing and should be remedied. The elastic theory as applied to masonry arches is treated very clearly, with a practical example illustrating its use.

Frank P. McKibben is the editor of the chapter on steel structures, such as buildings, bridges, tanks and bins. The general data on bridge design with comparative specifications for loads, stresses and details, should prove of value to the designer. Methods of design and detailing of various structures are given in a manner which should appeal alike to the student and engineer.

Section 9 is a full treatise on hydraulics and water power, by Gardner S. Williams, setting forth in a very complete and clear manner, water supply sewerage and irrigation. Section 10 is edited by Allen Hazen, with the aid of G. C. Whipple and Herbert M. Wilson. This part of the book treats of a very large subject in such a concise manner as to cover the entire ground thoroughly in the limited space allowed. Alfred Noble and Silas H. Woodard are the authors of the section on dams, aqueducts, canals, shafts and tunnels. A very complete compilation of data on dams, aqueducts and tunnels is a feature of this chapter.

Section 12, mathematics and mechanics, by Edward R. Maurer, covers the field in a very complete way and should be invaluable to the engineer who wishes to "brush up" on the subject. Chemistry, physics, meteorology, weights and measures, by Louis Fisher, is a section containing many valuable reference tables.

The two new sections added to this edition are section 14, by G. A. Goodenough, setting forth those fundamental principles and facts of steam and electric engineering which are of especial importance to civil engineers, and section 15, by A. H. Blanchard, giving the most recent practice in the construction and maintenance of highways and streets. The chapter on streets and roads is without doubt one of the most up-to-date in the book, and is a notable addition to this handbook, the work of some of America's best engineers.

THE NEW BUILDING ESTIMATOR. By William Arthur. Eleventh Edition 1913, Revised and Enlarged, 4½x7. Leather 732 pages. Published by David Williams Co., New York City. Price $3.00.

Estimating the cost of buildings is a business in which no fixed laws or prices can be followed. It is therefore of great benefit to the architect contractor, engineer and builder if he can refer to some up-to-date volume of authentic comparative cost data while making up estimates or appraisals. The New Building Estimator we can unhesitatingly recommend as a book which will be invaluable for such work being the result of years of experience and observation by a man recognized as an authority on estimating. That the book has been kept up-to-date is shown by the fact that it has passed through eleven editions since 1904, increasing from 150 pages to the present size and always increasing in value.

The introduction is a mint of valuable suggestions to estimators given in the author's brief and "to the point" manner. The book is divided into two parts, Part One—Approximate Estimating, and Part Two, Detailed Estimating. Data for estimates of any kind pretaining to buildings can be found in the various chapters. Chapters on the cost of reinforced concrete buildings of the latest types of construction give complete and detailed information in such a form as to be of the most value to the estimator. The costs of railroad buildings including stations, depots, shops of

all kinds, foundries, round houses and miscellaneous structures are given on both square foot and cubic foot basis. Three chapters are devoted to the subjects of depreciation, physical valuation both in general and in detail. These chapters should be of interest to the railway engineer since the author has had a vast experience in this line of work.

By supplementing this excellent work with one's experience and personal data the estimator should have a fund of information, the value of which cannot be set down in terms of dollars and cents.

THE BUILDING AGE HANDY ESTIMATE BLANKS. Compiled by Arthur W. Joslin, 1912, 7½x10. Paper. 28 pages. Published by David Williams Co., New York City. Price 25 cents each, $2.50 per doz.

These blanks furnish a convenient form for the use of contractors and builders in making estimates and also for recording the cost of work executed. Space is provided for recording every item which usually occurs in residences, small factories and office buildings. They should for this reason be of great benefit to the estimator in that he will not be likely to forget to estimate certain things when it is down in black and white before him.

MILL BUILDINGS. By Henry Grattan Tyrrell, 6x9, cloth, 500 pages, 650 illustrations, published by the Myron C. Clark Publishing Co., Chicago. Price $4.00.

This book differs from previous books on the subject of buildings in that the mathematical methods of design and graphical statics are omitted entirely with the result that the reader is given much valuable information on details of construction not found in the earlier works on this important subject. Much of the subject matter dealing with various kinds of roofing materials, gutters, downspouts, skylights, windows, doors, paints, etc., is exceedingly valuable to the owner, architect and engineer because of the fact that this information which heretofore had to be obtained from various trade catalogues is presented in a complete and unbiased manner.

Part 1 treats of the economic theory of design as regards location, purpose, arrangement of plant, size and type of building, lighting, ventilating and comparative costs of wood, steel and reinforced concrete buildings. In this portion of the book the author gives the reader information of a character which is forthcoming only from an engineer who has very broad experience in this line of construction. This part alone is worth many times the cost of the book, and can be read and studied with profit by the student, builder, plant manager, architect and engineer alike.

The various loads to which mill buildings are subject are given in Part II. Steel, wood and concrete framing including Northern light roof framing are next treated with many illustrations of the various types. Part IV. Details of construction is without doubt the most complete treatment of this subject ever published and should prove invaluable to the designer. The final part deals with the organization of engineering and drafting departments of structural works with chapters on estimating quantities and costs of steel buildings.

The general arrangement of the book, the typography and illustrations are excellent and it can be said without hesitation that Mr. Tyrrell has rendered a distinct and valuable service to owners, architects and engineers.

ARTISTIC BRIDGE DESIGN. By Henry Grattan Tyrrell, C. E. First Edition 1912, cloth, 6x9 in. 294 pages, 150 illustrations. Myron C. Clark Publishing Co., Chicago. Price $3.00 net.

This book which is a systematic treatise on the design of modern bridges according to aesthetic principles is a unique and very acceptable volume treating of a subject so generally avoided by bridge engineers in this country in the past. The trouble has been that the one thing foremost in the mind of the designer has been to cut the cost to a minimum to the exclusion of artistic considerations, in order to meet competition. The result is apparent on every hand and Mr. Tyrrell has taken it upon himself to show wherein and why these structures are ugly. This he has accomplished in a manner such as only an engineer of the widest experience in such work would be capable of. To quote from the preface: "The lack of art is no doubt partly due to the dearth of literature on the subject and the difficulty in securing good illustrations, and it is hoped that this book will assist in producing better results." We cannot help but feel that any engineer who carefully reads and studies the illustrations in this interesting volume, which by the way, is remarkably free from the usual flowery language found in treatises on art, cannot fail to form better ideas of the proper lines and treatment of artistic bridges.

The introduction by Thomas Hastings of the well known firm of architects Carrere and Hastings, New York, is a plea for collaboration between the engineer and architect in order to produce better results from the practical as well as the artistic view point, with resulting economy in time and money. The first part of the book deals with the importance of bridges, reasons for artistic bridges, standards of art, causes for lack of art, special features of bridges and the selection of the proper type of structure. Chapter VI is an instructive exposition of the general principles of artistic design, which are (1) selection of the most artistic form consistent with economy, (2) expressiveness, (3) symmetry, (4) simplicity, (5) harmony and contrast, (6) conformity with environment, (7) proper combination of materials, (8) a judicious use of applied ornamentation. Several chapters are devoted to the various types of steel and masonry structures with illustrations showing how aesthetic principles have been disregarded or carried out, as the case may be. The rest of the book is given over to a beautiful set of illustrations, with descriptions, of some eighty bridges of wood, masonry and steel, of various types.

The general arrangement, typography and illustrations are exceptionally fine. The only objection to the work, one that could be remedied very easily and would add greatly to the value of the book, is the numbering of illustrations and figures without captions which necessitates a search in the text in order to ascertain what is being illustrated.

Mr. Tyrrell is deserving of great credit for the publication of this interesting work on a subject which heretofore has been treated only to a limited and incomplete extent in various treatises on bridge design.

The Blue Ridge will build a passenger station at Anderson, S. C., which will cost approximately $100,000.

The Carolina, Clinchfield & Ohio will construct coal piers at Charleston, S. C., to have bunkers with a capacity of $350,000 tons. Modern machinery for handling coal will be a feature of the equipment.

The Delaware, Lackawanna & Western, it is reported, has tentative plans for a new passenger station at Utica, N. Y.

The Erie will soon begin the erection of a depot and office building in Meadville, Pa. The building will be erected on the site of the present structure and will be large enough to put all of the company's Meadville offices under one roof. The station will also be used by the Bessemer & Lake Erie.

The Great Northern, it is reported, will build a new office building at Superior, Wis.

The Lehigh & New England, it is reported, has decided to establish new shops at Bath, Pa. One and one-half million dollars will be expended on this and other improvements.

The Louisville & Nashville and the Chesapeake & Ohio, it is reported, are planning a new joint passenger station at Covington, Ky.

SPECIFICATIONS FOR PORTLAND CEMENT, D. L. & W. R. R.

The specifications for Portland cement issued on Jan. 1, 1913, by the Delaware, Lackawanna & Western R. R., (published in full below), are the result of a long series of tests carried on by H. J. Force, engineer of tests, to ascertain the causes of disintegration of concrete in numerous structures on that company's lines. The ordinary accelerated or boiling tests previously used were found to be unsatisfactory and the new autoclave boiling test has been adopted to take its place.

Definition.

1. The cement shall be the product obtained by finely pulverizing clinker produced by calcining to incipient fusion, an intimate mixture of properly proportioned argillaceous and calcareous substances, with only such additions subsequent to calcining as may be necessary to control certain properties. Such additions shall not exceed 3 per cent, by weight, of the calcined product.

Specific Gravity.

2. The specific gravity of the cement shall not be less than 3.10.

Fineness.

3. Ninety-five per cent of the cement, by weight, shall pass through the No. 100 sieve, and 80 per cent of the cement, by weight, shall pass through the No. 200 sieve.

Time of Setting.

4. The cement shall not acquire its initial set in less than 1 hour and must have acquired its final set within ten hours.

Soundness—Force Autoclave Test.

5. Three neat briquettes to be made up in the usual manner and allowed to remain in the damp closet for 24 hours. At the expiration of that time, the briquettes are to be removed from the moulds and placed in the autoclave, sufficient water being added to partly or wholly cover the briquettes. The autoclave is then closed, the burners being of sufficient size to raise the pressure to 295 pounds in not more than 1 hour. The pressure of 295 pounds shall be maintained for 1 hour longer, or a total time of 2 hours. The pressure is then to be gradually released, the briquettes taken out and placed in the moist closet, where they shall be allowed to remain for 1 hour. At the end of that time they are to be broken in the standard cement testing machine in the usual manner. The average tensile strength of the three briquettes taken from the autoclave must show a tensile strength of not less than 500 pounds per square inch. They must also show an increase of not less than 25 per cent. over the average tensile strength of three briquettes broken at the end of 24 hours. A bar of neat cement, 6 inches long by 1 inch square, shall be made up at the same time the briquettes are made. This expansion bar to remain in the moist closet for 24 hours and to be removed along with the briquettes and tested with the briquettes in the autoclave, as indicated above. After one hour in the moist closet, this expansion bar shall not show an expansion greater than one-half of 1 per cent.

Tensile Strength.

6. The minimum requirements for tensile strength for briquettes 1 inch square in section shall be within the following:

Age	Neat Cement	Strength
24 hours in moist air		200 lbs.
7 days (1 day in moist air, 6 days in water)		500 lbs.
28 days (1 day in moist air, 27 days in water)		600 lbs.
ONE PART CEMENT, THREE PARTS SAND.		
7 days (1 day in moist air, 6 days in water)		250 lbs.
28 days (1 day in moist air, 27 days in water)		375 lbs.

The average of the tensile strengths developed at each age by the briquettes in any set made from one sample is to be considered the tensile strength of the sample at that age. Any results that are manifestly faulty will not be included. The sand briquettes will be thoroughly tamped in the moulds by using an iron die to fit inside the sand briquette mould, this die to be struck a number of blows with a wooden mallet.

Composition.

7. In the finished cement, the following limits shall not be exceeded:

	Per Cent.
Loss on ignition for 20 minutes	4
Insoluble residue	1
Sulphuric anhydride (SO_3)	1.75
Manganese (MgO)	4

Insoluble Residue.

8. The insoluble residue shall be determined on a 1-gram sample which is digested on the steam bath in hydrochloric acid of approximately 1.035 specific gravity until the cement is dissolved. The residue is filtered, washed with hot water, and the filter paper contents digested on the steam bath in a 5 per cent solution of sodium carbonate. The residue is then filtered washed with hot water, then with hydrochloric acid, approximately of 1.035 specific gravity, and finally with hot water, then ignited and weighed. The quantity so obtained is insoluble residue.

Inspection.

9. All cement which is used by the above named Company, or any contractors doing work for the above named Company, must be sampled at the mill. The inspector will take a sample from each and every car and properly seal the cars with the Company's seals.

In no case must cement be shipped from any mill without the Company's inspector being present. Should it be necessary at any time to ship cement without inspection at the mill, but which inspection will be made at point of destination, the shipper must so notify the Chemist and Engineer of Tests, and receive special orders from him for the shipping of the cement.

The Inspector must have access to all parts of the mill, either day or night, when any contract is being filled for the Company.

The shipper must furnish the office of the Chemist and Engineer of Tests with analysis and physical tests showing results obtained upon the bin from which shipments are made.

Samples take from every car will be sent to the Laboratory for further test and inspection. Any sample which fails to meet any or all of the above requirements will be condemned and returned to the shipper, who must pay freight charges in both directions.

Samples of cement obtained from cars which continue to show a lower result at the end of the 28-day sand test than is shown in the 7-day sand test will be sufficient cause for the canceling of any contract which at that time may be in force.

Few persons realize that about 1,100 lbs. of raw material must be ground and nearly 200 lbs. of coal burned to produce a 380-lb. barrel of cement. The labor expense incurred to obtain these raw materials, including coal, is very heavy and amounts to about half the cost of a barrel of the finished product. In 1911 about 78,500,000 barrels were produced in the United States, the average annual price per barrel being 84.4 cents.

The American Cement Tile Mfg. Co., of Pittsburgh, has been awarded the contract by the government for about 650,000 sq. yds. of reinforced cement tile for covering the roofs of the 16 new shop buildings at Balboa on the Pacific side of the Isthmus of Panama. The tile will be manufactured at the site under government inspection. That cement tile should have been selected for this work speaks well for them since the heavy rains in Panama will put any roof to a most severe test. Cement tile have proven their fitness under actual conditions in government tests.

The Missouri & North Arkansas is to spend $1,000,000 on track and terminal improvements. The improvements are to be made by the receivers and embrace the entire length of the road from Helena to Joplin, Mo.

Design of Retaining Walls.

By Alfred W. Hoffmann.

While in all matters pertaining to the design of steel and concrete beams, girders, slabs, columns and most other structures, a certain degree of uniformity has been obtained, due to the increasing knowledge of the action of these structures under stress, the opinions of the best engineers regarding the design of retaining walls differ so much that they are difficult to reconcile.

Efforts to standardize the design of retaining walls have, in many cases, been aimed in the wrong direction, and in consequence thereof, rules have been made which, based as they were on a superficial study of the conditions, led to objectionable practices. Such rules are handed down from one generation to the other, and it is time some of these time-honored rules be discarded for better ones based on a more thorough understanding and on the practical experience of many years.

The first and most essential condition for the design of a wall retaining an earth fill, is a knowledge of the external forces acting on the wall. The computation of the external forces offers no difficulties, except the earth pressure, which tends to overturn the wall. The design of a retaining wall is, therefore, primarily based on the theory of earth pressure. The actual pressure of the earth fill against the back of the wall is the most uncertain factor of the design, and depends on the character of the filling material, moisture, drainage, and various other conditions. It is not proposed to discuss in this paper the merits of the different theories of earth pressure, in view of the fact that even the most refined theories are based on assumptions which, in many cases, are very far from representing the actual conditions. Nothing is to be gained by too high a degree of refinement in the preliminary computation of the overturning forces. The most important consideration in the preparation of a retaining wall design must always be to secure a reasonable degree of safety at reasonably low cost. Such safety cannot be gained by mere theoretical speculation and by laboratory tests, but simply by experience, by the study of failures, by comparison with similar structures which have given satisfactory results, and, last but not least, by a careful consideration of the actual conditions governing each given case. A paper on the design of retaining walls should, therefore, be based on a careful and comprehensive study of the available data as well as on experience in this line of work. In the preparation of this article, both the American and foreign literature on this subject have been consulted and the data combined with the writer's experience, especially in the discussion of the most modern types of reinforced concrete retaining walls. In these some improvements will be described which have been adopted in railway work upon the writer's suggestions.

Although there exists a vast amount of literature on this subject, a comprehensive review of the present day practice appears to be opportune, as the information is scattered over the pages of many hand books and periodicals. A good many publications on retaining wall design are merely of a descriptive nature, while others are either too theoretical or too superficial. The consequence is that wrong conclusions regarding the economy of the more modern types of retaining walls are drawn and repeated.

This subject should be treated as a whole, including theory, construction and economy. The writer fully realizes his shortcomings in his attempting to review a subject of this magnitude and importance. He desires by this paper to contribute something toward familiarizing the designing engineer and more especially the railway designing engineer with this subject, which has not received the attention which is its due because of its economic importance.

The statement made before that too high a degree of refinement is unnecessary and undesirable is not meant to belittle the value of theoretical investigations and laboratory work. In fact, such theoretical work cannot be too highly valued, as one of the most important elements in building up a more exact theory of design of retaining walls and similar structures. It must be emphasized, however, that the designing engineer at present is not so much interested in an absolutely correct theory of earth pressure, as in a safe and practical theory. There is too much hair-splitting in the earth pressure formulas on one hand, while on the other hand, some factors in these formulas depend on the character of the filling material, of which in most cases very little or nothing is known to the engineer when he sets about designing a retaining wall.

We should try to get away from hair-splitting as well as guessing; we shall see to what extent assumptions can be made without getting too far away from the probable or actual conditions. Based on reasonable assumptions, it is proposed to use simple yet reasonably correct methods to determine stability and stresses in retaining walls without losing sight of safety and economy.

We are on much safer ground when it comes to determining internal stresses. Although our knowledge regarding internal stresses in retaining walls is very limited, we know as much about them as about the stresses in beams or cantilevers. For these latter, however, the external forces are, in most cases, easily determined, and with greater certainty than the internal stresses. The chief disadvantage of the retaining wall as compared with the beam is the uncertainty regarding the external forces, and especially regarding the earth pressure. Even for the same material used in backfilling the earth pressure is not always the same, as might be expected, for the pressure depends not only on the soil, but also on the method used in depositing the earth, on the provision for drainage, the danger of frost, and other conditions. It seems reasonable, therefore, to substitute safe assumptions for too highly refined methods of determining the actual earth pressure, which is by no means a fixed amount. The basis for such reasonable assumptions can be formed by comparison with structures which have given good service without excessive deformation.

It should be emphasized, however, that there is an element of danger in such comparison unless it is supplemented by a careful analysis of the actual conditions governing the design of the two walls being compared. The fact that a wall of a certain width of base and height retains a fill without any signs of trouble is not conclusive proof that a duplicate of this wall will give equally good service in a different location. As a matter of fact, stability, although the most important factor in retaining wall design, is by no means the only one. Two identical walls retaining a backfill of the same kind produce an almost identical pressure on the underlying soil. If the subsoils in the two cases under consideration differ in their compressibility, then the toe of one wall will sink deeper into the soil than the toe of the other wall. Consequently one wall will lean over more than the other or, in other words, the deformation of one wall is greater than that of the other wall. If the soil is very compressible, the deformation may become excessive, and lead to ultimate failure, while another wall of identically the same proportions may just fit the local conditions. It can readily be seen, therefore, that besides stability, deformation and soil

pressures are very important factors, the inter-relations of which have to be analyzed in order to arrive at practical rules for the design.

From these simple facts it is evident that so-called "rules of thumb" for the design of retaining walls contain an element of danger. It is a regrettable fact that hand-books and railroad specifications give such "rules of thumb" with any guidance as to their limitations. It is common practice to design retaining walls, at least those of the gravity type, by the application of a formula for the proportion of the width of base to the height, the most common formula being the one which requires a width of base of four-tenths of the height. Such rules do not take the soil pressure, nor the height into account, yet they are frequently used utterly disregarding variations and differences in the local conditions. To throw some light on these inconsistencies, by actual figures and diagrams, is not the least aim of this paper. The writer has had occasion to observe the weaknesses of retaining walls and abutments in railway work, caused by faulty proportions. To his knowledge, the true relation of width of base to height, toe pressure and safety against overturning has never been worked out systematically, although there is, of course, nothing novel about these relations. It seems strange that engineers have accepted rules and standards which are faulty because they fail to make allowance for some of the most essential factors entering in the design of retaining walls. If any "rules of thumb" are to be used at all in the design of retaining walls, then the limitations of their applicability should also be clearly stated.

General Analysis. This investigation comprises five distinct types of retaining walls, two of which belong to the group of plain gravity retaining walls, while the remaining three belong to the group of reinforced concrete retaining walls. Hereafter in this article, these types will be referred to as follows:

1st Group. Plain Gravity Retaining Walls.	**Type I.** Plain Concrete or Masonry Gravity Retaining Wall with Vertical Back and Battered Front. **Type II.** Plain Concrete or Masonry Gravity Retaining Wall with Vertical Front and Battered Back.
2nd Group. Reinforced Concrete Retaining Walls.	**Type III.** L-Shaped Reinforced Concrete Retaining Wall with Low Percentage of Reinforcement. **Type IV.** L-Shaped Reinforced Concrete Retaining Wall, Highly Reinforced. **Type V.** Counterfort or Buttress Reinforced Concrete Retaining Wall.

Besides these five types, special types will be described, such as retaining walls for track elevation and depression on limited right of way, retaining walls showing decorative treatment, and foreign and other types.

The following elements are to be considered in the design of retaining walls:

1. Stability or safety against overturning.
2. Safety against sliding.
3. Bearing on soil.
4. Stresses in structure.
5. Drainage and protection against destruction by frost.

A general analysis of these elements may precede the detailed discussion of each type.

Stability.

The earth fill exerts a pressure against the back of the retaining wall, the direction, and amount of which are figured by the use of various theories. Of the different ones, Rankine's theory lends itself most readily to practical application. Whatever the direction of the earth pressure as determined by other theories may be, the vertical component does not add to the forces which tend to overturn the wall. Only the horizontal component has that tendency, and corresponds to the earth pressure as computed by using Rankine's theory, which assumes a horizontal force acting against the vertical back of the retaining wall if the surface of the fill is horizontal. To assume the same pressure acting against any retaining wall regardless of batter of back, and to consider a sloping surface as surcharge, is on the side of safety, and reasonable at the same time. A higher degree of refinement is not necessary for the computations, considering the rough assumptions made in the application of Rankine's formula, and the more or less crude nature of all our computations of stresses. For an exhaustive study of Rankine's and other earth pressure theories the reader is referred to the handbooks. The clearest discussion of the various theories is to be found in the latest edition of M. S. Ketchum's "Design of Walls, Bins and Grain Elevators."

As is generally known, the Rankine formula for vertical back and horizontal surface of fill is

$$P = \tfrac{1}{2} w h^2 \frac{1 - \sin\Phi}{1 + \sin\Phi}$$

where w = the weight of the fill per cubic foot,

h = the height of wall, or height from top of wall down to horizontal section under consideration,

Φ = the angle of repose of the earth to be used in back-filling.

For $h = 0$, the earth pressure will be $P = 0$.

P represents the total earth pressure above the horizontal section at the distance h below the top of the wall.

The diagram of the earth pressure P is a triangle as shown in Fig. 1. The area of the triangle is

$$wh \frac{1 - \sin\Phi}{1 + \sin\Phi} \times \frac{h}{2} = \frac{wh^2}{2} \cdot \frac{1 - \sin\Phi}{1 + \sin\Phi} = P.$$

The intensity of earth pressure or the earth pressure per square foot at any section at the distance h from the top of the wall is $wh \frac{1 - \sin\Phi}{1 + \sin\Phi}$ The factor w is constant for every kind of filling material. The fraction $\frac{1 - \sin\Phi}{1 + \sin\Phi}$ is also a constant value for every kind of fill, depending as it does solely on the angle of repose. It is plain, therefore, that the earth pressure, for any kind of earth, is a linear function of the height of the wall, as is shown in the diagram Fig. 1. The center of gravity of the earth pressure is ⅓h above the base. The factor

$$\frac{1 - \sin\Phi}{1 + \sin\Phi}$$

can easily be determined for any angle of repose; it is 0.286 for a natural slope 1½ to 1. This slope is flat enough for most kinds of earth, and is the standard slope of many railroad embankments which are subject to the most severe atmospheric influences. The figures based on this factor will, therefore, be on the safe side except in special cases. Assuming a weight of earth of 100# per cubic foot, the intensity of earth pressure is $0.286 \times 100h = 28.6h$, and the total earth pressure will be

$$P = 28.6 \frac{h^2}{2}$$

A rock fill weighing 150# per cubic foot with a natural slope of 45° will exert an earth pressure of $.172 \times 150 = 25.8h$ per sq. ft. at the distance h below the top, and a total earth pressure of

$$P = 25.8 \frac{h^2}{2}$$

Any load applied on the fill near the back of the retaining wall also produces a pressure against the wall. This applies especially to railroad work where retaining walls are often designed to retain tracks on an earth fill at a higher elevation. It is common practice to figure the superimposed load per square foot, and express it in feet of earth fill. If, for example, the center line of a railroad track is located 6 ft. 6 in.

from the back of the retaining wall, and the live load is Cooper's E-50, then the maximum load per lineal foot of rail is $\frac{25000}{5} = 5000\#$ and the load per square foot of surface is $\frac{5000}{6.5} = 770\#$ which corresponds to 7.7' of fill at 100# per cubic foot.

Let h' be the height of the surcharge, then the pressure per square foot at the top of the wall is

$$28.6h'$$

and the pressure per square foot at the base is

$$28.6\,(h'+h).$$

The diagram of the total pressure is then, a trapezoid as shown in Fig. 2. The rectangle represents the pressure due to the surcharge, and the triangle represents the earth pressure. The center of gravity of the live load pressure is ½h above the base, and the center of gravity of the earth pressure is ⅓h above the base. The sum of the earth pressure and live load pressure is

$$P + P' = 28.6\frac{h^2}{2} + 28.6\,h'h$$

$$= 28.6h\left(\frac{h}{2} + h'\right)$$

Sometimes the following method is used for railroad work

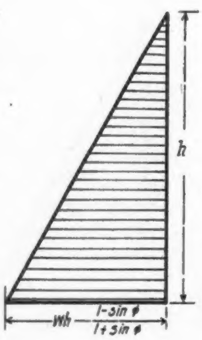


Figure 1.

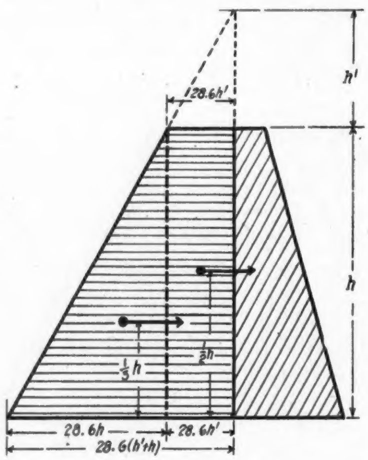


Figure 2.

to determine the pressure caused by the live load surcharge.

The surcharge is assumed to spread through the earth 3 ins. in 12 ins. Above the intersection of the line of spread, which originates at the end of the ties, with the back of the wall, the surcharge is assumed not to produce any horizontal pressure.

At and below this intersection the intensity of the horizontal live load pressure is

$$.286\frac{L}{\frac{b}{2} + \frac{h}{4}},$$

where L is the live load per lineal foot of rail, and b is the length of the ties. For Cooper's E—50 Loading,

$$L = \frac{25000}{5} = 5000\#$$

The live load thrust remains constant down to the base of the wall. The diagram of the live load thrust is a rectangle. In Figs. 4a and b the earth pressure and live load thrust diagrams are shown, as figured according to both methods discussed before, for a wall of 24 ft. height, supporting on a fill a railroad track, the center line of which is 5 ft. from the back of the wall, the live load being Cooper's E-50 loading, the length of the ties being 8 ft.

According to the first method the surcharge is

$$\frac{25000}{5 \times 5} = 1000\#$$

corresponding to a height of 10 ft. The thrust at the top of the wall is 10 × 28.6 = 286# per square foot. The total earth pressure is

$$P = 28.6\frac{24^2}{2} = 8237\#$$

The total live load thrust is

$$P' = 286 \times 24 = 6864\#$$

The sum of all overturning forces is

$$P + P' = 8237 + 6864 = 15101\#.$$

The diagram Fig. 4b shows that the total thrust as determined by the second method is but slightly different from the thrust according to the first method. The earth pressure is, of course, identically the same. There is no surcharge on the first 4 ft. from the top of the wall, as the line of spread of the live load intersects the back of the wall 4 ft. below the top. At that elevation the live load per square foot is $L = \frac{25000}{5 \times 5} = 1000\#$ and the iive load thrust at that elevation and down to the base is .286 × 1000 = 286# per square foot. This thrust is the same as found before. The total live load thrust P' = 286 × 20 = 5720#, and the sum of the overturning forces is

$$P + P' = 8237 + 5720 = 13957\#.$$

The only difference between the two methods is the omis-

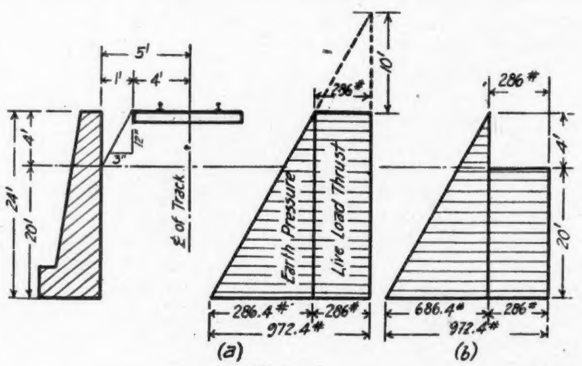


Figure 4.

sion of the rectangle of the live load thrust above the intersection of the line of spread of the live load with the back of the wall. The first method is always on the side of safety, the second is more correct. Of course, in cases where the track is relatively far distant from the back, the first method would give absurd results.

Whether and to what extent impact should be considered in the computation of the live load thrust must depend on the railway's requirements in each case.

Retaining walls which are carried deep below the ground line (see Fig. 5) are often figured for an earth pressure from the top of the fill down to the ground line only. It is then assumed by the designer that there is equilibrium between the earth pressure against the wall from both sides, below the ground line. This assumption is erroneous, as can be seen by comparing the earth pressure diagrams from both sides, Fig. 5. At the ground line the earth pressure from one side is 28.6 (h—h') while the earth pressure from the other side is zero. The only influence of the fill in front of the wall is a reduction of the total earth pressure against the back of $28.6\frac{h'^2}{2}$. The diagram of the resultant earth pres-

sure is, then, a triangle from the top to the ground line, and a rectangle from the ground line to the base. If there is a heavy live load applied on top of the fill, the actual condition is very far from equilibrium below the ground line. The small amount of earth pressure in front of the wall may then be entirely neglected without committing a serious error. It is safer, *in all cases*, to neglect the pressure against the front of the wall, as the front might be exposed down to the base for repairs or changes of the ground elevation, and then the stability of the wall might be seriously endangered.

Stability of a retaining wall is obtained by forces whose moments around the toe of the wall are counteracting the moments of the overturning forces around the toe. The forces which give a wall its stability are the weights of the wall itself and as much fill and surcharge as may be carried on the base of the wall. As the stability does not so much depend on the weights themselves as on the distance of their centers of gravity from the toe, it is evident that assuming the same weight for two different types of walls, the one whose center of gravity is farther distant from the toe is the more stable. In designing an economical retaining wall, it is, therefore, desirable to concentrate as much weight near the heel as practicable. On the other hand, it is evident that, if a certain factor of safety against overturning is specified, a wall with its center of gravity near the toe will have

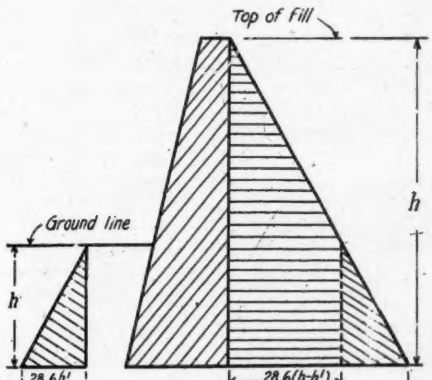


Figure 5.

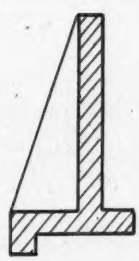


Figure 6.

to be made wider at the base, and heavier than one with the center of gravity near the heel. This simple law is sufficient to prove how essentially wrong rules for designing are which call for a certain fixed proportion of width of base to height, regardless of the type selected, surcharge and other conditions.

As far as methods of stabilization are concerned, retaining walls can be classified as follows:

(1.) Retaining walls which resist overturning mainly by their own weight, or gravity retaining walls. (2) Retaining walls which resist overturning mainly by the weight of the prism of earth carried on the heel.

Those of the first class must necessarily be heavy and of solid masonry. They are, therefore, generally speaking, of plain concrete. The internal stresses in such large masses of concrete are so low that no reinforcement is required.

The latter class is typical for comparatively light walls which must be reinforced with steel to take the tensile stresses in the structure.

For every retaining wall the condition for stability is that the righting moment is equal to or larger than the overturning moment, all moments taken around the toe. Graphically this means that the resultant of all forces acting on the wall must pass inside the base. The farther back from the toe the resultant intersects the toe, the greater is the factor of safety against overturning. In railroad work the factor of safety should be 2, or not much less than 2. If impact is neglected the factor of safety should never be less than 2. The fact that the factor of safety against overturning is not only a function of the proportion of base to height, but also of the type of wall, will be most convincingly demonstrated by the diagrams for stability which have been prepared for the detailed discussion of the various types of retaining walls.

Sliding.

Whenever the angle between the resultant of all forces and the base is less than the angle of friction between the base and the subsoil, then the retaining wall tends to slide on the soil. The friction between masonry and different kinds of soil varies considerably; as a general rule, however, it can be said that on wet clayey soils the danger of sliding is much greater than on dry sand or gravel. On soils which offer little resistance to sliding positive methods for the prevention of sliding should be used. The most commonly used detail is to let a part of the footing project deeper into the soil as shown in Fig. 6. The projection should be proportioned to take the full horizontal component of the resultant, without relying on the friction between base and soil at all. This detail will be discussed at somewhat greater length in connection with the various types of walls.

Bearing on Soil.

Next to stability, the bearing on the subsoil is the most important consideration in the design of retaining walls. It

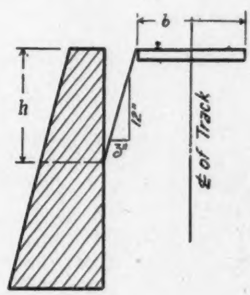


Figure 3.

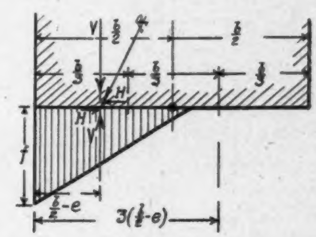


Figure 8.

has been mentioned before that the practice of proportioning retaining walls by "rules of thumb," on the basis of a certain proportion of base to height is a dangerous one. The width of base is not only a function of the height but also of the type of wall selected and of the allowable bearing on foundation. A diagram has been prepared illustrating these functions, which will be shown in a later issue.

The bearing on foundation for a resultant passing through the center of gravity of the base is uniformly distributed over the base, and is a minimum. In a retaining wall the resultant of all forces is always inclined, and very rarely passes through the center of gravity of the base. As the resultant intersects the base it can be resolved into one horizontal and one vertical component. The horizontal component is resisted by the friction between soil and base, and the vertical component, which is equal to the sum of all vertical forces acting on the wall, produces the reaction of the soil which is called bearing. If the resultant passes outside of the center of gravity of the base, then the bearing is a maximum at one extreme side of the footing, and a minimum at the other, and it varies as a straight line.

The extreme fibre stresses can be easily found by the application of the formulas for flexure and direct stress combined. The direct stress equals the resultant vertical forces

divided by the area of the base. If the distance between the center of gravity of the base and the intersection of the resultant of all forces with the base, e, be called the eccentricity, then the bending moment is the product of the resultant vertical force times the eccentricity e. The extreme fibre stress produced by this moment equals the moment divided by the section modulus of the base. This fibre stress is compression at the toe and tension at the heel if the resultant passes in front of the center. This is almost universally the case in retaining walls.

Let V be the vertical component of the resultant of all forces, or the sum of all vertical forces in lbs. for one foot of retaining wall, $f' =$ the direct stress in pounds per square inch, $b =$ the width of base in inches, $f'' =$ the extreme fibre stress due to the bending moment, in pounds per square inch, $e =$ the eccentricity, in inches.

We obtain from the figure the following:

$$f' = \frac{V}{12b}$$

$$f'' = \frac{Ve}{1/6 \times 12 \times b^2} = \frac{Ve}{2b^2}$$

The extreme fibre stress due to combined flexure and direct force is

$$f = f' = f''.$$

These stresses are shown in Fig. 7.

If $f' > f''$, then the stresses are compression over the whole base. If $f' < f''$, then the extreme fibre stress at the toe is compression, and at the heel it is tension.

If $f' = f''$ the compressive stress at the toe is twice the average, and the stress at the heel is zero. When $f' = f''$ we get the equation $\frac{Ve}{2b^2} = \frac{W}{12b}$ which can be solved for

$$e = 1/6b.$$

The stress at the heel is zero if the resultant passes through the third point of the base. It is compression all over the section if the resultant passes inside the middle third. The stresses change from compression at the toe to tension at the heel if the resultant passes outside of the middle third. This rule applies to all sections taken through a material which can take tension. Between the base of a wall and the soil, however, there is no medium which can take tension, and therefore the above formulas apply only to all cases where the resultant passes inside of the middle third or through the third points.

If the resultant passes outside of the middle third, then the pressure on the soil can be determined by putting the reaction of the soil equal to the sum of the vertical forces.

The diagram of the soil pressure is a triangle the center of gravity of which is on the line of the vertical component of the resultant of all forces, as shown in Fig. 8. This condition gives the equation

$$12 \times 3\ (\tfrac{1}{2}\ b - e) \times f = V, \text{ whence}$$

$$f = \frac{V}{36\left(\frac{b}{2} - e\right)}, \text{ for one foot of wall.}$$

The portion of the base back of the triangle of soil pressure does not bear on the soil.

Internal Stresses and Deformations.

The three factors of the design which were discussed before, govern the general proportions of the retaining wall. Besides these general proportions the internal stresses must be looked into, with a view to avoiding excessive stresses in any part of the structure. In the plain concrete gravity retaining walls this is a very simple matter. Compression is always very low in these massive structures. Therefore, to see that the tension on the concrete does not exceed the allowable limit, is all that needs be done in figuring internal stresses for those types of retaining walls.

The conditions are entirely different, however, with the modern types of reinforced concrete retaining walls. To proportion the structure so as to be safe against overturning and sliding, and not to exert excessive bearing on the foundation, is in many cases the least part of the work involved in designing walls of the highly reinforced types. The internal stresses and the requirements for taking care of them are still the subject of much discussion. It will be shown that practices have developed which are, to say the least, doubtful, and which would not be tolerated in the more advanced design of slabs and girders, where the action of the external forces is more clearly understood. These types of

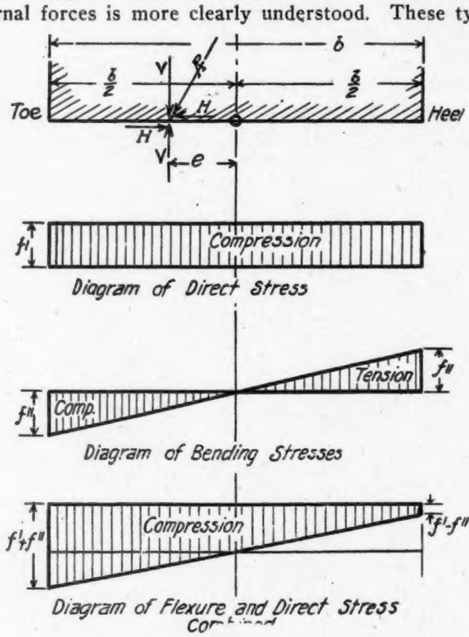


Figure 7.

highly reinforced concrete walls will, therefore, be treated at greater length than any other subject connected with the design of retaining walls.

One factor which is too often neglected is the deformation of the structure. The pressure on the soil is a maximum at the toe, and a minimum at the heel. Consequently the soil is more compressed at the toe, and the retaining wall leans over bodily a certain amount, depending on the settlement of the toe. Besides this deformation, which is very important because not sufficient care is taken in many cases to keep the toe pressure low enough, there is the deformation of the wall itself, due to internal stresses, to be considered. This secondary deformation is comparatively small and insignificant in massive gravity and in reinforced concrete counterfort retaining walls. It is, however, an important factor in the design of higher L-shaped walls.

Drainage and Frost Protection.

Success with retaining walls, especially of the reinforced concrete types, depends as much on adequate provision for drainage and protection from damage by frost as on right proportions and reasonable stresses. Much stress should, therefore, be laid on these factors for the right treatment of which experience is the most reliable guide. The best modern practice regarding drainage and frost protection will be discussed later as well as methods of making concrete impervious.

Economy.

The principal difference between the two main groups of retaining walls is in the material used to give the structure

stability. The gravity wall resists, overturning by the weight of the concrete itself, in the reinforced concrete walls, the weight of the earth fill is utilized for the stability of the structure. It is evident that a very important element of economy is introduced by the principle of using the cheap filling material to make the retaining wall stable against overturning, instead of using the more expensive concrete for the same purpose. It must, however, be kept in mind, that this economic advantage can only be gained at the expense of reinforcing the concrete rather heavily. There are, of course, limits for the economy of all types, and there seems to be a great diversity of opinion regarding these limits. It is, however, almost generally conceded that, generally speaking, for greater heights the reinforced concrete types are more economical than the plain gravity types. Railways and other corporations have different standards for economical thicknesses of walls, and percentages of reinforcement, and consequently their practice differs regarding economic limits for the various types. Different examples will be discussed, and the economy of retaining wall design will be made a special study of in conclusion of this series of articles.

(To be continued.)

A despatch from the West states that the Grand Trunk Pacific has decided to divert its Moose Jaw branch into Swift Current, Sask., and that, although construction from Watrous will go right ahead, the steel should be laid into Swift Current at least twelve months earlier than the other lines, after which it will be possible to work both ways. The despatch, in fact, anticipates that the Grand Trunk Pacific will be in Swift Current by the end of the year.

The Louisville & Nashville is said to be considering an expenditure of about $500,000 for enlarged terminal facilities, repair shops and other improvements at Louisville, Ky. This road has also plans for enlarging its yards at Lexington, Ky., which will probably cost about $500,000.

The Maine Central will start plans soon for 8 steel bridges between Bangor and Vanceboro. These will cost about $130,000.

The Minneapolis, St. Paul & Sault Ste. Marie is reported to be planning improvements at its Shoreham, Minn., shops which will include the following new buildings and additions: Storeroom building, $200,000; addition to blacksmith shop, $43,000; extension to roundhouse, $40,000; wood-working shop, $35,000; flue shop, $23,000; battery house and tool house to cost $10,000 each. Other expenditures for equipment and tools will make the total cost of $400,000.

The New York Central Lines have awarded a contract to the Walsh Construction Co., Davenport, Ia., for a bridge over Bridge Canal, at Forbridge, N. Y. It will be a six-track bridge, 100 feet long, of concrete and steel.

The New York, New Haven & Hartford will proceed with the erection of a new freight station at Hartford, Conn., as soon as the city decides on the location of two new streets near the proposed station.

The Norfolk Southern has awarded contract for 2 bridges in Raleigh, N. C.

The Oregon-Washington & Navigation Co. is planning the construction of a concrete and steel freight house at Tacoma, Wash. This freight house will be 50 feet wide and 600 feet long with a two-story headhouse 50 by 50 feet for offices.

The Pennsylvania is preparing to build a bridge 450 feet long over the tracks at Whitney, on the new trolley line from Hecla to Latrobe, Pa.

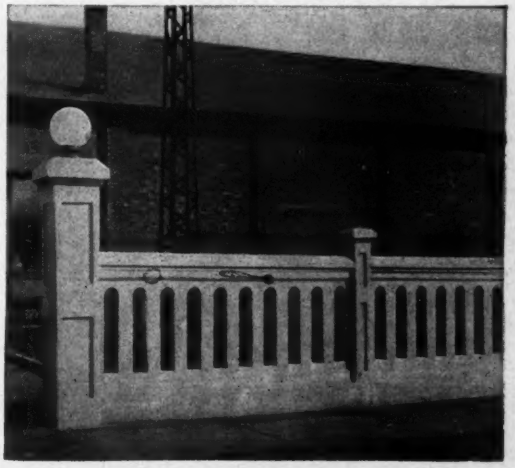
The Philadelphia & Reading is reported to have contracted with the Phoenix Bridge Co. for a double track girder bridge at Stony Creek, Pa.

REINFORCED CONCRETE FENCE.

The Carnegie Steel Co. has recently built 557 ft. of reinforced concrete fence of attractive design, at its plant at New Castle, Pa. The cost of this fence, including seven large gate posts surmounted by electric lights, was 76 cents per lineal foot.

The gate posts, 18 ins. square and 8 ft. high, and the panels between intermediate posts, were cast in place. The intermediate posts, 9 ins. square and 5 ft. 9 ins. high, and the post and panel caps were built in collapsible "unit" forms. The forms were oiled, plastered inside with 1:3 cement mortar, and then filled with 1:2:3 gravel concrete, the reinforcing bars being put in corners of posts and panel caps.

The intermediate posts were set in place, 11 ft. centers, and concreted into the sub-base of 1:3:6 gravel concrete. The panel base of 1:2:3 concrete was cast in place and the panel forms erected immediately after and filled with 1:3 mortar,



Reinforced Concrete Fence.

mixed wet and well tamped. The panels are 4 ins. thick and 5 ft. high, with arched openings 6 ins. wide, 12 ins. centers. The reinforcement of the panels consists of 3/8-in. bars horizontal at top and bottom and one 3/8-in. bar vertical between openings, put in place after concrete was poured. The top rail of the panels is 6 ins. wide.

After setting, the concrete was washed with a mixture of lye, alum, cement and water, which produced a surface with light gray color, free from cracks or check marks and with a soft and uniform tone throughout. Universal Portland cement was used in the erection of this fence.

The Philadelphia & Reading it is reported, will erect two new repair shops at Palo Alto, Pa.

The Southern Pacific will soon be asking bids for the construction of a passenger station, Los Angeles, Cal. The new station building, with its track accessories, will cost about $750,000. This road will soon begin construction work on a new passenger station at Porterville, Cal., at an estimated expenditure of $30,000.

The Southern Pacific is reported to be about to let contracts for a bridge across the Willamette river at New Era, Ore.

The Baltimore & Ohio it is reported is considering building a line from Romney, W. Va., to Harrisonburg, through the Alleghenies by way of Lost City, Mathias and the Brooks section of Rockingham county, and connecting with the valley branch at Harrisonburg.

Chesapeake & Ohio has has entered into contract with Elkhorn Fuel Co., of Fairmont, W. Va., to build 20-mile line from Beaver Creek to Kentucky coal lands.

The Signal Department

AUTOMATIC BLOCK SIGNALS ON THE ATLANTIC COAST LINE R. R.

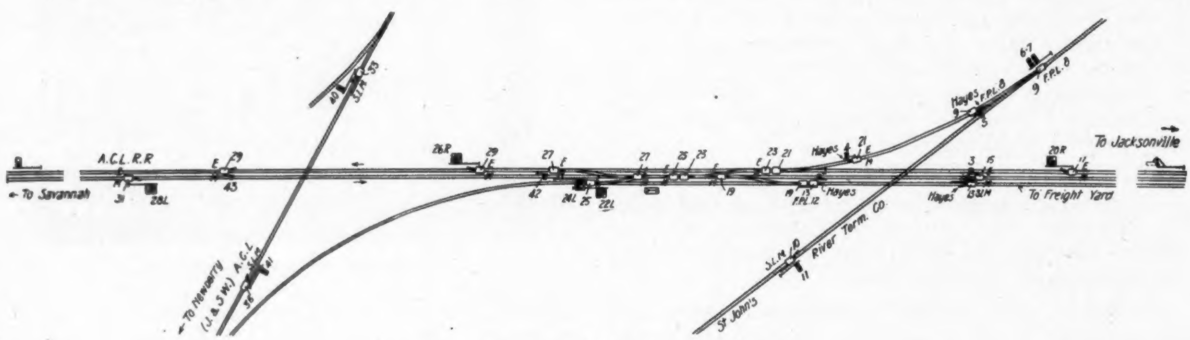
B. W. Meisel.

The automatic block, and interlocking signal equipment installed between Folkston, Ga., and the S. A. L. crossing at Jacksonville, Fla., protects 40 miles of double track with three electro-mechanical interlocking plants at the following points: Moncrief, Fla., Callahan, Fla., and Folkston, Ga.

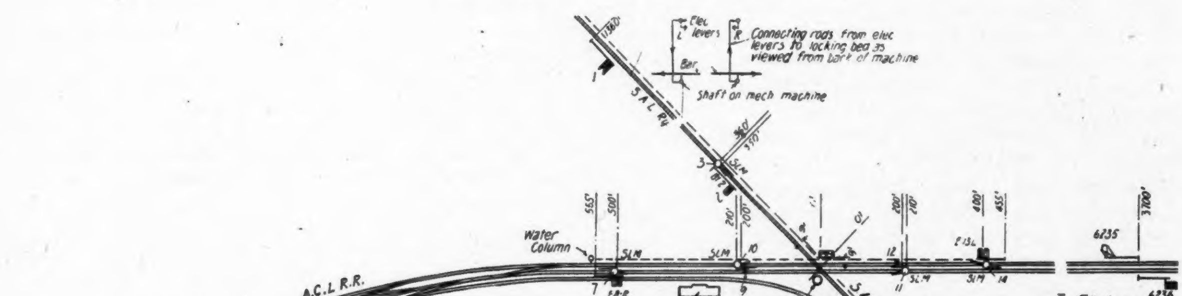
Automatic block signals were first used on this section in 1909, these being superseded by the recent installation. The straight line layout of tracks and signals, shown herewith, gives all the information necessary for a general understanding of the location of all automatic and main line interlocking signals, also the location of all switches, curves, stations, mile posts, highways and bridges. The grade is given in feet per mile with an arrow to indicate the up and down grades. The point of the curves and tangents is also indicated with the direction of each. At each automatic signal location a certain standard wiring plan is referred to, as typical, for that location, which may be typical of other locations as well. With a scheme of this kind, where typical (standard) wiring plans are used, and a location chart marked to show which one of the wiring plans is to be used at each location, the need of continuous wiring plans is eliminated. Some Signal Engineers, however, require a continuous set of wiring plans as well as the typicals. At the interlocking plants the circuits become special and, in this case, require continuous plans.

For the 82 automatic signals there are five typical circuit plans, used as follows: One each of A 909 and A 428, four of A 422, five of A 421 and 71 of A 427. Typical wiring plan A 427 is shown herewith, to illustrate the circuit most used, and to show how simple it is to tie in the circuit plan with the location chart.

Referring again to the location charts, note the quantity and quality of information that can be secured from a few straight lines and notes, all of which aid in reducing the work in the drafting room to a minimum and at the same time give sufficient knowledge of the work under way for the contractor to bid on, and for the men in the field to



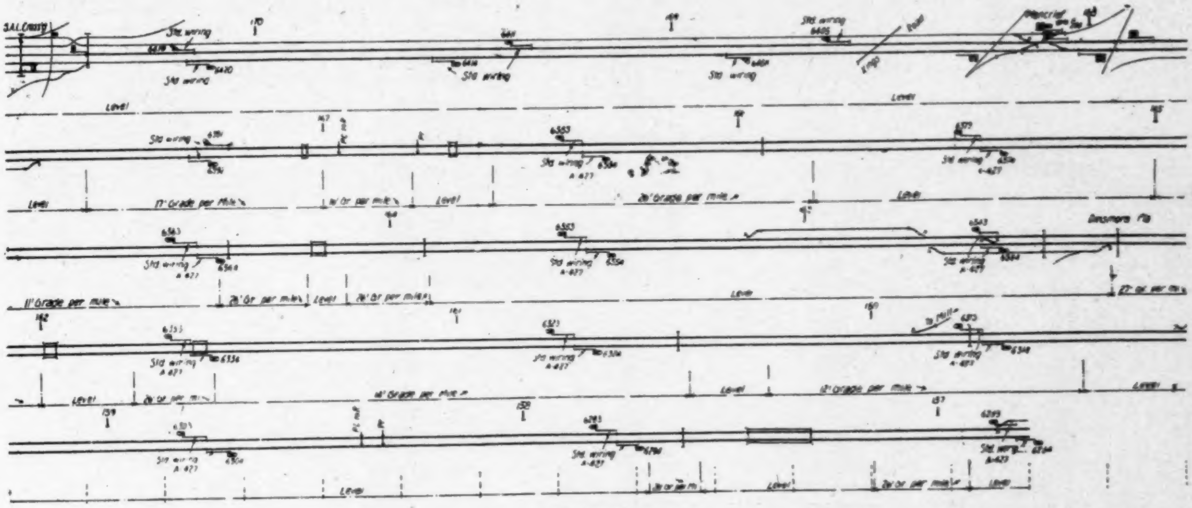
Track and Signal Layout, Moncrief, Fla.



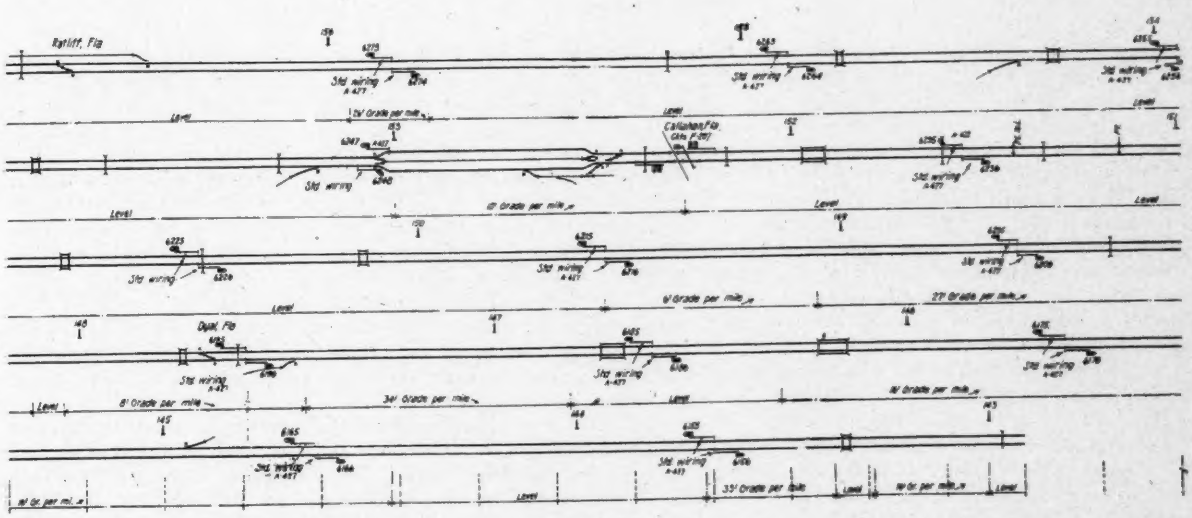
Track and Signal Layout, Callahan, Fla.

Track and Signal Layout, Folkston, Ga.

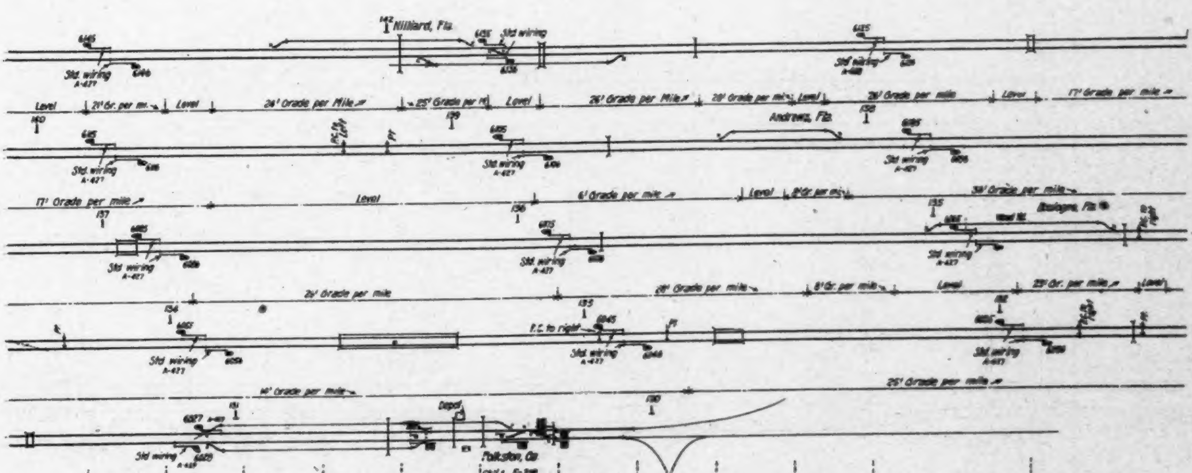
SIGNAL LOCATION CHART BETWEEN S. A. L. CROSSING AT JACKSONVILLE, FLA., AND FOLKSTON, GA.



Section 1.



Section 2.



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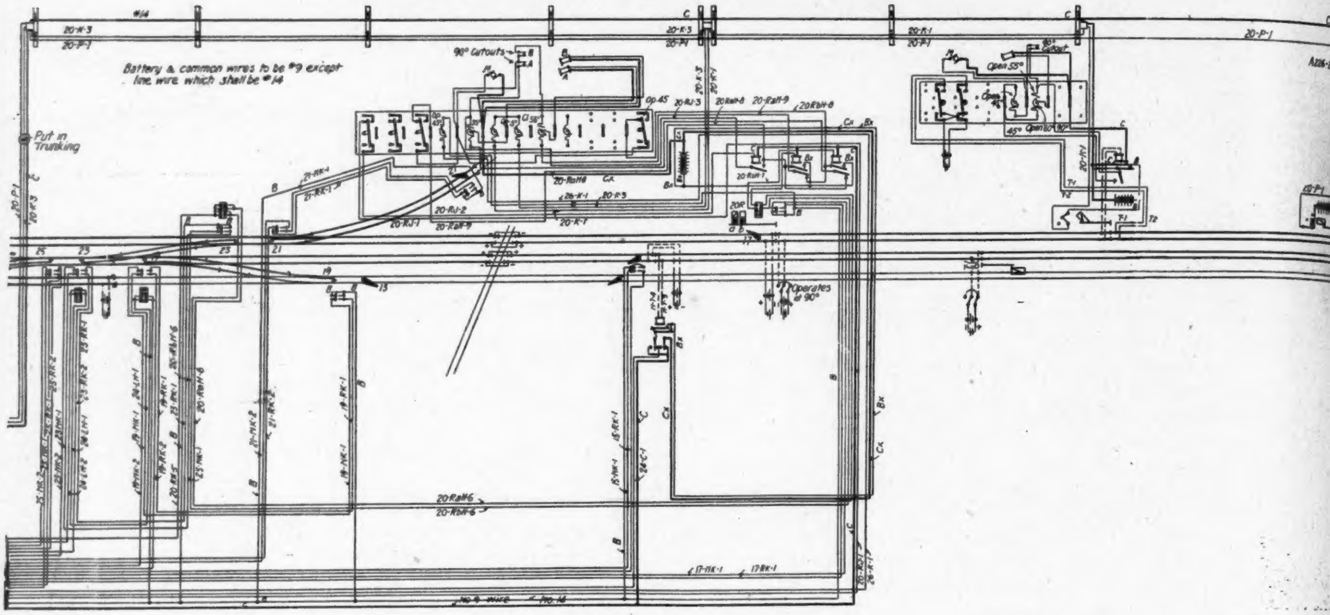


Circuit Plan, Moncrief, Fla.

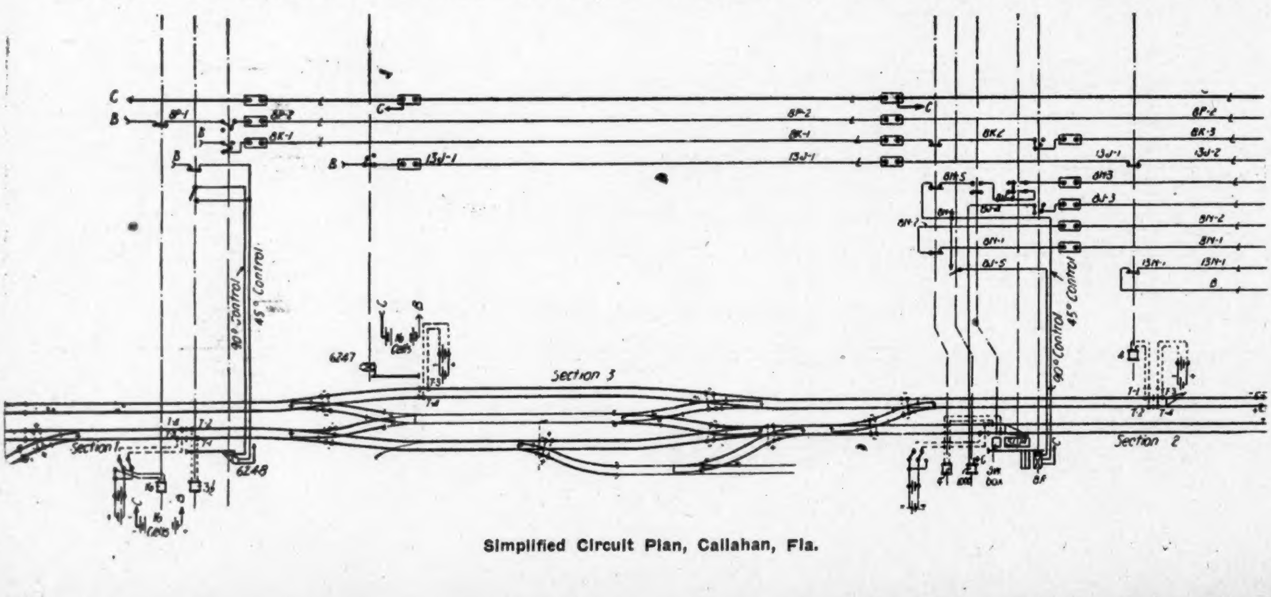
work with. It finally gives a complete and reliable office record which can easily be revised with but very little labor.

The same general scheme, of simplifying, and of labor saving, has also been successfully carried out, it will be seen, with the circuit plans of the two interlocking plants at Folkston and Callahan. These are termed "simplified circuit plans," by the signal department of the A. C. L. R. R. And a comparison with a similar layout of circuits for Moncrief interlocking shows that they have been well named. In the first case the general scheme has been to keep each circuit in as near a straight line course, from one piece of apparatus to another, as possible. While in the latter case the circuits take all sorts of paths.

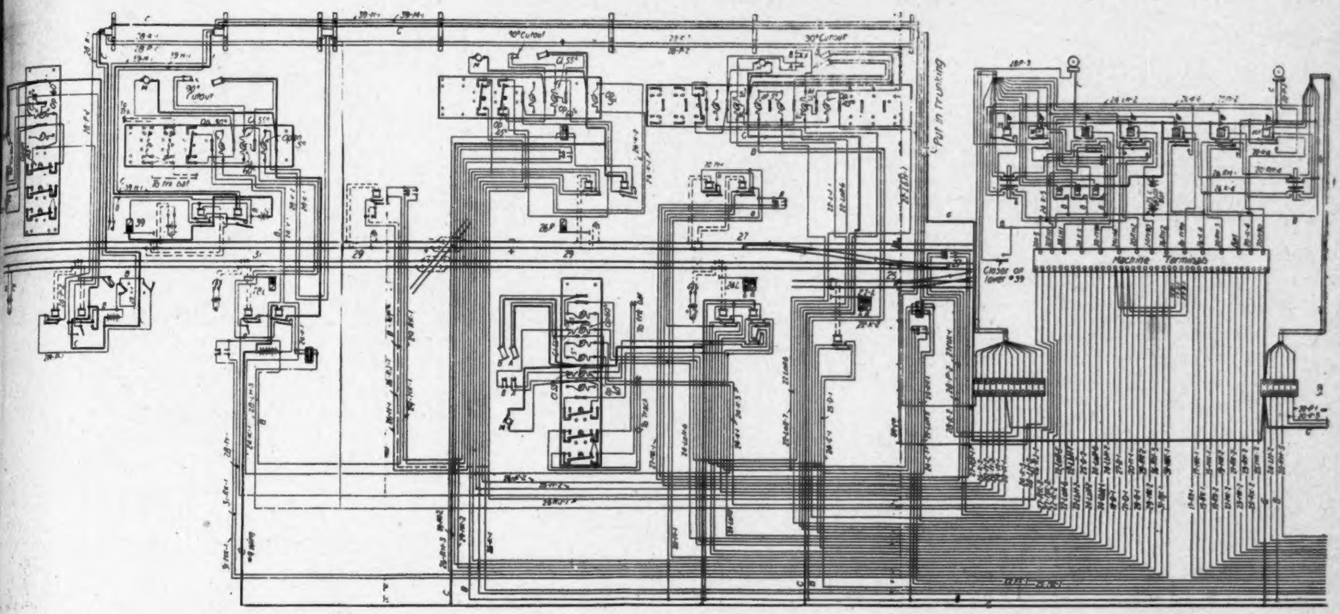
All automatic and main line interlocking home signals are the Union Switch & Signal Co.'s style "S," upper right hand quadrant type; operating in three positions (0°—45°—90°). The automatics are controlled by polarized track circuits, approximately 5,200 ft. long, the track circuit being operated by two cells of gravity battery connected in multiple. The direction of the flow of the battery current in the track circuit depends upon the position of the pole changer operated by and located at the signal, at the battery end of the track section. When the signal is clear the position of the pole changer is such that both neutral and polarized points of the track relay at the other end of the track section are picked up; and when the signal indicates caution or stop, the pole changer is reversed, and the current flowing from the battery in the track circuit, is reversed; hence the polarized points drop away and the neutral points remain closed, except when a train enters or is within the block, in which case both polarized and neutral points are open.

The signals are operated by a bank of 16 cells of B. S. C. O. battery connected in series, and located in the battery section of each signal case. The night indications are: White for clear, green for caution and red for stop. Switch indicators are not used.

The electro-mechanical interlocking plant at Moncrief was put in service July 16th, 1910, and at that time was one of the largest plants of its kind in the country. Track plans of this plant and also the plants at Callahan, Fla., and Folkston, Ga., are submitted herewith to show the relation and locations of functions. At Moncrief the mechanical ma-



Simplified Circuit Plan, Callahan, Fla.



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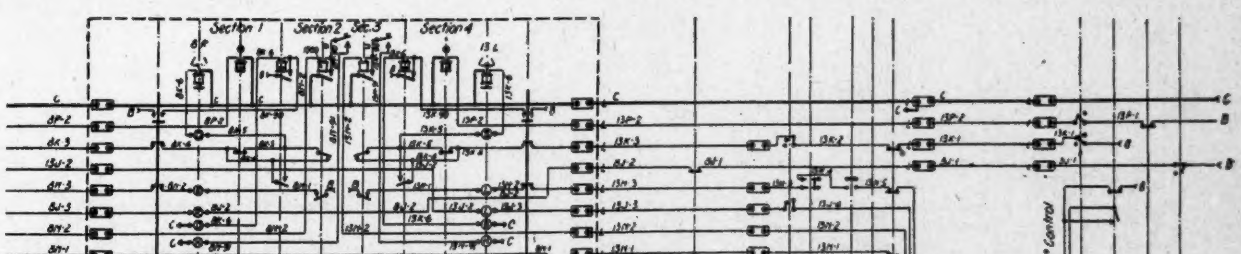
chine has 28 working levers with 4 spare spaces. Twelve levers are used for signals, 14 levers for switches and derails, and 2 for facing point locks. The electric machine has 14 working levers and 9 spare spaces. Five levers are used for signals and 9 for switches.

The electro-mechanical interlocking plants at S. A. L. crossing Callahan, Fla., and at Folkston, Ga., are both of the very latest type, employing the most modern and latest methods of construction. The former was put in service June 29th, 1911, and the latter October 14th, 1912. The mechanical machine at Callahan has 12 working levers with no spare spaces, and the electrical machine 2 levers for 2 signals. At Folkston the mechanical machine has 10 levers for signals, 5 for switches and derails and 5 for facing point locks with 4 spare spaces. The electrical machine has 7 levers for 7 signals.

All main line interlocking home signals are semi-automatic, the movement from horizontal to 45° being controlled by track circuits and small electric levers; the movements from 45° to 90° is automatic and is governed by indications of the first signal in advance. Back locking is used in connection with all power operated interlocking home signals, with approach and route locking for all main line movements.

The following plans are shown here to illustrate the standard practice and method of construction used throughout the entire layout of signal protection; Standard layout of trunking at a signal location; standard boot leg for underground construction; standard boot leg joint, and standard wire joints.

The method of making the boot leg joints is as follows: A copper clad bond wire is bent into the form shown in Fig. 1, the four turns on each end being made around a 1 in. piece of iron. Next the braid of the No. 9 rubber covered copper wire is pulled back, and the rubber is cut as shown in Fig. 2. After removing the rubber, the wire is thoroughly cleaned, care being taken to prevent injury from cuts, etc. Fig. 3 shows the connection completed. The splice must be made tight after which it is well soldered, without



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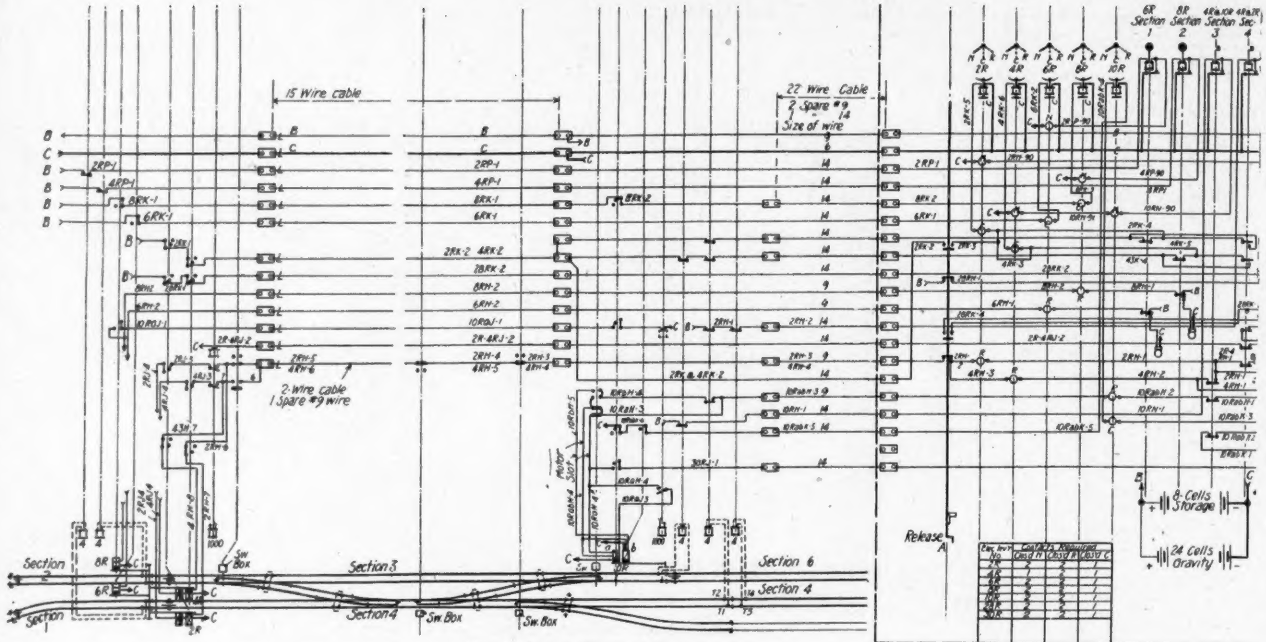
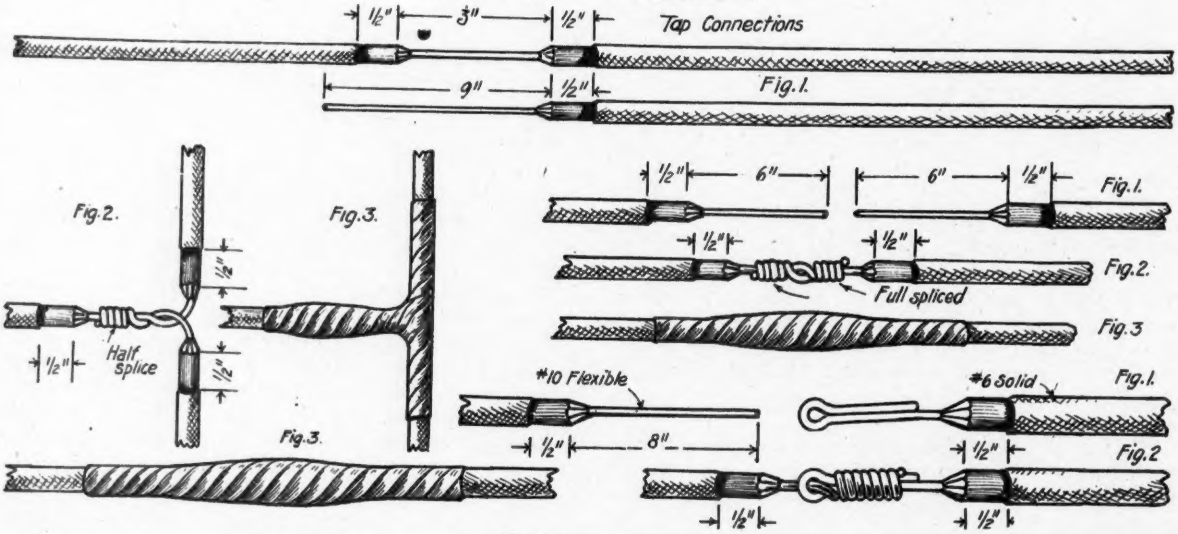
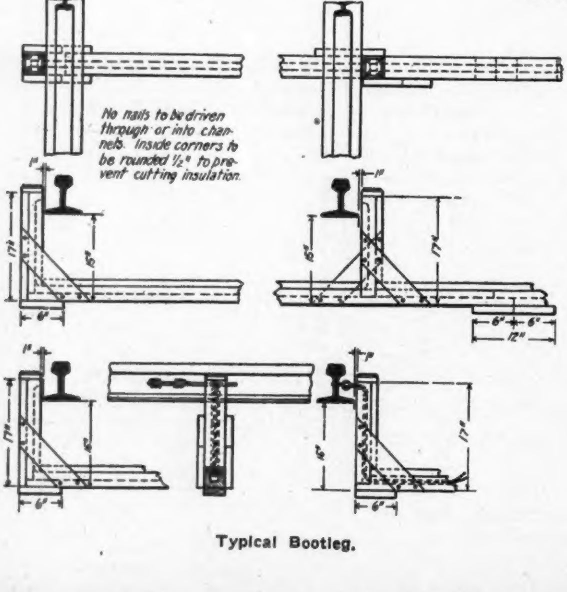


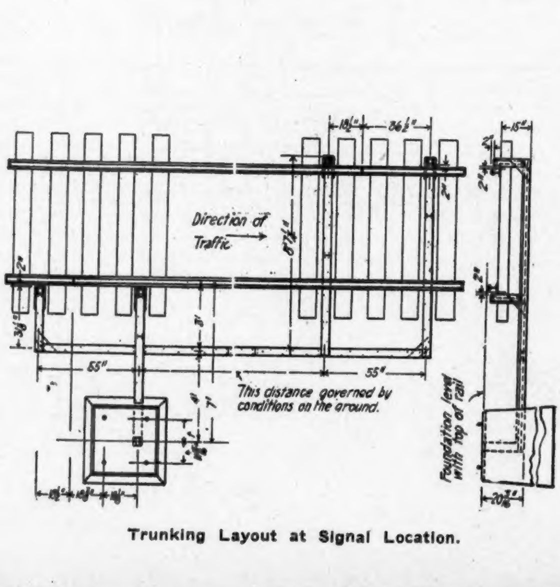
Simplified Circuit Plan, Folkston, Ga.



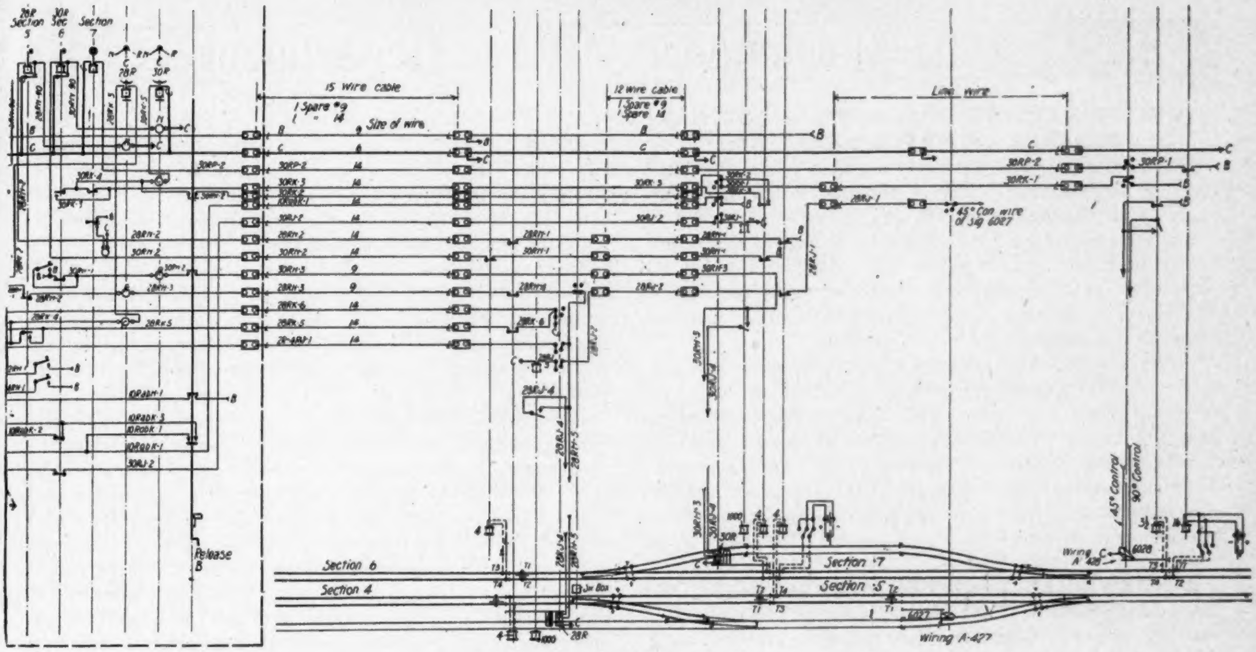
Typical Wire Joints.



Typical Bootleg.



Trunking Layout at Signal Location.



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acid, washed and heavily coated with insulating compound. For all other wire joints the same precautious are followed in preparing the wire for the joints. After the joints are well soldered without acid, washed, and dried, they are heavily coated with insulating compound, wound tight with two layers of Okonite tape between the ends of the braids so as to form a tight covering, and heavily painted with P and B paint. Two layers of Grimshaw tape are then applied one inch beyond each end of first tape, and heavily painted with P and B paint. Splices are not allowed in underground cables.

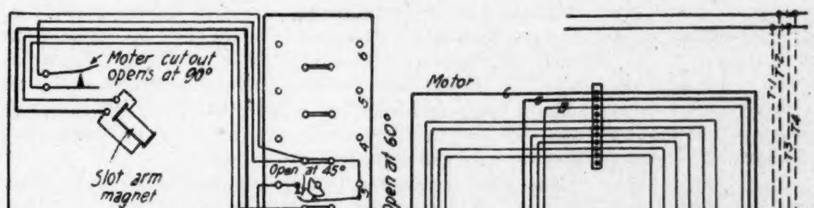
All of the above work was installed by the railroad company's forces under the supervision of C. J. Kelloway, signal engineer, and under the direction of Mr. W. J. Lee, electrical foreman, Mr. J. L. Royall, mechanical foreman and Mr. J. O. Underwood, superintendent of construction. We are indebted to C. J. Kelloway, signal engineer of the Atlantic Coast Line R. R. for the information given herewith.

It is said that active steps are being taken towards an immediate start on construction of the San Diego & Arizona between San Diego, Cal., and Yuma, Ariz.

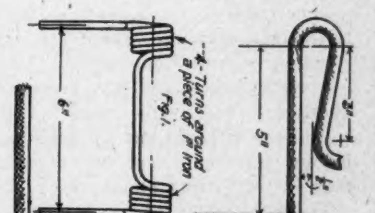
The Duluth South Shore & Atlantic has awarded a contract to Connell-Wicks Co., Duluth, Minn., for constructing a 2,000-ft. extension track into the mines at Palmer.

The Grand Rapids & Northwestern will probably commence construction soon on the proposed line between Grand Rapids and Ludington, Mich. The company plans to market $3,500,000 of bonds to finance the work.

The New Iberia & Gulf, which has been surveyed from New Iberia, La., to Weeks Island, will probably start construction work at an early date. The right of way has already been secured.



A-427, Typical Wiring Plan.



Bootleg Joint.

The Maintenance of Way Department

COMMITEE MEETING, ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION.

A general meeting of all the committees of the Roadmasters and Maintenance of Way Association was held February 15, at the Auditorium Hotel, Chicago.

The meeting was called to order by President Wm. Shea, and a discussion was held on subjects assigned for the September, 1913, convention. This meeting is the first of the quarterly meetings of the committees, these meetings being an innovation.

Thirty members were present, representing twelve railways. Lack of space prevents a complete report of the meeting. These men were put to considerable personal expense to attend this meeting, all of which will result in benefiting the railways represented, and the association. The large attendance and the fact that the men attended this convention at their own expense, proves the interest of the members and their hearty support of the Association.

A NORWEGIAN ENGINEER'S IMPRESSIONS OF AMERICAN CONSTRUCTION METHODS.

Claude L. Van Auken.

A division engineer of the Norwegian Government Railways recently visited the United States to study American construction methods. The writer was afforded the pleasure of piloting this visitor around on construction work near Chicago and, although conversation could only be carried on in broken English, many differences were discovered in the manner in which work is done in Norway as compared with the United States.

The first peculiarity of which the gentleman spoke was brought out shortly after the meeting in a downtown railway office. It was the matter of downtown traffic encountered on the way from the office to the depot. After endeavoring for two blocks to walk upon the left hand side of the walk, the visitor asked why we walked upon the right hand side in America. A walk of 6 or 8 blocks in the busy streets of Chicago brought out the fact that the impression received from the narrow, crowded, noisy streets with the unsightly elevated structures was anything but favorable.

"The passenger coaches are too crowded, the aisles are too narrow and one cannot see out of the windows when standing without stooping."

A round trip ticket was purchased, which brought the question: "Is it really round?" The equivalent expression in Norway is "Fare and a Half," from which we see that by buying a return ticket one saves much more in Norway than in the United States.

The work inspected was the construction of a large hump yard involving over a million cubic yards of filling. After watching the laborers—Greeks and Italians—for a few minnutes, the visitor asked: "Why do not the men work?" And again, "What method of getting work done is employed?" He was told that the men—laborers and foremen, both—were hired and paid daily wages, that the men in charge laid out the work and the foreman was responsible for getting the work done. His reply should set railway officials to thinking, it was this: "I think the 'daily wages' system is not good."

In Norway the track laborers are either Norwegians, Finns or Swedes; a foreman has charge of from 8 to 15 men and he is given a portion of the work to do and is assigned a certain sum of money for that portion of the work. Hence, the faster the laborers work, the sooner they finish, and the more money they make.

The visitor was much interested in the modern track jack. He lifted one from the ground so as to estimate its weight, and asked why 4 Italians were assigned to one jack. In Norway the track jack is not known and the track is lifted with long levers. The Norwegian was much pleased with the track jack and took many notes and photographs.

The construction of engine houses, machine shops, coal chutes, clinker pits and other terminal facilities did not seem to interest the man at all, unless the work was done by machinery. Wherever there was machinery in action he wanted to be, and there he took copious notes and numerous photographs.

Little or no machinery is used in Norway in the construction of railways, and the reputation of America in that country seems to be that almost everything is done by machinery here. The Lidgerwood unloaders with their side plows and center plows were objects of intense interest to the visitor, and he followed these almost incessantly during the unloading work. Following the unloading crews was an air operated spreader of the Jordan type. The great capacity of this machine as a labor saver, together with its ease of operation, seemed nothing short of marvelous to one not accustomed to American ingenuity and progress.

The Scandinavian railways use the local soft woods for cross ties and each main cross tie is fitted with tie plates, which are thicker on the outside than on the inside, giving the rail a slight cant inward, which is believed to decrease spreading and offsets the natural tendency of the rail to gradually tilt outward in service.

"The American works too hard and too long without sufficient rest;" "There is too much hurry in America," are conclusions of the civil engineer from northern Europe. In Christiana, Norway, the general offices of the government railways work from 9 a. m. to 2 p. m., and from 5 p. m. to 7 p. m. each day. Undoubtedly the Norwegians might profit by adopting some modern American construction methods, but on the other hand the Norwegians have ideas which Americans might adopt with profit.

ESSENTIAL QUALITIES IN A TRACK FOREMAN.

Thomas Cain.

Track work is not especially designed for the purpose of fitting a man directly for the daily duties of his future work on track. It takes time to develop a talent for a particular task. A laborer must have practice and be trained by an older, experienced man. The latter has many difficulties to meet in practice, efficiency and methods of instruction. Make a man and he will find his work.

The older section foremen are rapidly passing away. The age limit will take out a large number of them in a few more years. If a section foreman has a good bright man, who has passed through the eighth grade, working for him on his section, he should give him an opportunity to make good and do his best to show him and instruct him, and then put him on as assistant foreman. Then he should be granted a little higher pay than the rest of the laborers on the section and that would be some encouragement for a man to stay and become a section foreman. But jealousy and fear that this young man will take his job some day keeps many a foreman from doing this. Such a foreman will put on the oldest man he has working for him as an assistant, one who has no education and never could become a section foreman, even after forty years spent on the track, for he stays in a rut and never gets any new ideas.

All the old road masters know this to be true. Why not give the young trackmen a show at once, that they may

know that they can expect something better than a common laborer's job, if they stick to track work? Let the roadmasters play fair with these young men, and have the old experienced section foremen teach them and show them all they know, in regard to running a section. Let them be given lessons every day in lifting and lining track and driving up and cutting where the track is creeping.

I have had young men working for me time and time again, and know they would make good section foremen by very little instruction. They had a fair education and were quicker to "catch on" than some of those that follow track work the year around. But when winter comes you have to let those young men go, and keep the old "Jerrys," because they are the oldest men on the section and they want their rights. The railroad companies should not throw away such opportunities, but should select one of these young men to fill the old foremen's place when his joints are getting rusty and he is not able to fill the bill and when the age limit is closing in on him. Section foremen are in great demand at the present time.

A young or old section foreman must cast aside any idea he may entertain that he has learned it all. There are new things to learn every day in track work. The average section foreman must look on the bright side of his daily duties even if he is working to a disadvantage. He must not get morose or sulky with his men. Fair and pleasant dealing is worth trying because men will take to their work more satisfactorily. A foreman should not lose his temper even if he is handicapped by starting in with inexperienced men on spring work.

Extra gang foremen cannot be made out of poor material. Track work requires study, practice and economical methods. For many years back all the roadmasters have been endeavoring to pick out capable men, from among the old experienced section foremen for extra gang foremen; those who with care and precision can get the greatest amount of work out of men. But it is found that all of the foremen are too liable to drive men. Creditable work on the track cannot be accomplished in that manner. This is due, in great measure, to the fact that our roadmasters constantly watch the daily reports of each extra gang foreman to detect which man turns in the largest report of work done for that day. They are ever anxious to show to the division engineer what was done that day by so and so. The extra gang foreman is aware of these facts and he tries to outdo his opponent, whether his track is in perfect condition or not. So it is practically impossible to pick out a capable man from them all.

The great scarcity of track laborers is due to small wages paid. You will often hear men say, "Give me a lumber camp or a sawmill or a factory or the industrial works in preference to track work." These are good American-born citizens and they can turn their hands to any kind of work and need no driving. Most men employed on extra gangs have no homes and possess no great amount of common sense. If they did they wouldn't be traveling from one job to the other all through the summer season. This class of men needs driving to a certain extent. The railways should solve the problem and it will be solved when it will be impossible to get good, practical foremen to work on the railroads.

A roadmaster should choose a track foreman as he would a first-class clerk in his office—that is, be sure he is endowed with a certain amount of intelligence and feel positive he is going to protect, guard, and handle the company's work with good judgment, for there are thousands of lives entrusted in his care when he is employed on track work. There ought to be enough good track foremen now to discriminate when hiring one. Do not forget that when you send a man out with fifty or sixty men in his charge you want to feel safe. Be sure he is the right man and will not abuse the position you have given him. A good extra gang foreman or a good section foreman usually means a well-kept track with everything in fit shape; with a careless one, it is the very opposite of this, and the least complaints received are generally from the good foreman who has given competent attention to his work. The true old track "Jerry" has a certain regard and pride for a piece of track he has just put the finishing touches on for inspection. He knows how to handle it under all disadvantages and knows how to get the utmost service from the gang of men he is foreman over, either by driving or coaxing them.

PROLONGING THE LIFE OF CROSS TIES.*

Howard F. Weiss.

Ties should always be thoroughly seasoned before being treated. In general, the bark should be removed when the timber is cut and the rate of seasoning regulated by the method of piling. Bark will oftentimes seriously retard the penetration of the preservative.

The rate of seasoning in air is greatly affected by the kind of stacking and arrangement of the tie stacks; by the kind of wood (soft wood can season faster than hard wood without checking); by locality (damp or cold weather retards seasoning).

Steam seasoning increases the moisture content of ties. It is necessary to steam season sometimes, but care should be taken not to apply steam pressure too high or too long, as the strength will be greatly reduced. Too fast application of final vacuum produces a similar result.

Oil seasoning causes wood to lose its moisture content constantly from the time of immersion. Interior checking is usually produced, being more serious in timber which originally has higher moisture content.

Preliminary soaking of ties in water leaches out sap, and ties lose moisture rapidly at first when air seasoning. Ultimately, however, they fail to reach as low a moisture content as unsoaked ties.

Grouping of timbers is very important, as uneven resistance to penetration results in erratic impregnation. Ties should be grouped into (1) species of wood of similar structure, (2) groups according to proportion of sap wood, (3) classes based on the moisture content. Ties of same species from different parts of the country may need to be separated when treating.

Ties should be cut late in the fall or early in winter to prevent case hardening or excessive checking, but aside from these the date of cutting does not matter.

Uniform impregnation depends on effective grouping. Thorough diffusion is necessary. Preliminary vacuum makes wood take preservative quickly, but gives uneven penetration and diffusion. Rapid increase in pressure does the same. It is good practice to hold the pressure at 75 lbs. and then increase 25 lbs. each 15 minutes up to desired amount.

If a final vacuum is not used, ties should be left in cylinder to drip, to avoid waste of oil.

Errors in measuring the oil impregnated occur on account of (1) ties absorbing oil as cylinder is being filled, and some ties are partially impregnated when cylinder becomes full, (2) temperature expansion of creosote, (3) temperature and pressure expansion of cylinder, (4) compression of oil and wood, (5) temperature expansion of wood. Errors may total 20 to 25 per cent.

Correct measurements of oil impregnated are obtained by subtracting the oil pumped back after treatment from oil in measuring tank before treatment, provided one measuring tank only is used. Tank scales give accurate results, experiments seeming to show little moisture is forced out of ties

*From Bulletin 118, Forest Service, U. S. Department of Agriculture.

during treatment. The use of track scales to weigh trams before and after treatment is good practice, but does not eliminate all errors unless the ties are removed from cylinder and weighed after steaming, which is impractical.

Tie plates serve two purposes. They distribute the wheel loads and absorb the grinding of the rail. Long flange plates are hard to embed, and gravel is liable to get between them and the tie. They also split the tie sometimes, allowing water to enter. Flat plates will rattle excessively it is claimed. Flat or short ribbed plates are probably best. Larger sized plates should be used on soft wood than on hard wood, and this feature should receive serious attention.

The holding power of drive spikes is increased by previous boring, provided the spikes are pointed on four sides and follow the holes and provided the proper size holes are used. Screw spikes have from 1.7 to 3.8 times the holding power of drive spikes and are being successfully used abroad. They give promise of overcoming the objections in this country, and if adopted will greatly decrease mechanical wear.

Sawed ties save lumber, save oil in treatment and give an even rail bearing. Hewed ties give an uneven bearing, have irregular volumes and cause waste of lumber of 25 to 75 per cent.

Consideration of data on the subject shows that a substantial saving is effected by treating practically all species of wood.

Recommended Practice.

(1) Ties should be cut in winter to decrease danger of checking, insect injury, and decay.

(2) Ties should be sawed rather than hewed.

(3) Bark should be removed when tree is cut, unless there is danger of case hardening; in any case, all bark should be removed before putting ties in cylinder.

(4) If ties are to be adzed and bored, it should be done before treatment.

(5) It is almost always cheaper and better to use treated ties.

(6) Preference for ties should be given to a hard wood which absorbs preservative readily.

(7) Ties with a large percentage of sap wood should be preferred, if it is well distributed, as sap wood is as strong as heart wood and is more readily impregnated.

(8) All ties should be thoroughly seasoned, preferably by air; if artificially seasoned, use low temperature to prevent checking.

(9) Tie-seasoning yards should be free from weeds and rotten wood and well exposed to air currents. Ground should be covered with cinders, and creosoted stringers should be used.

(10) Ties from conifers can be piled openly without much danger of checking.

(11) If ties season too slow, pile more openly, and vice versa. If cut in winter pile more open than if cut in summer.

(12) End checking can be retarded by S irons.

(13) Ties cut in Spring and Summer will in general be sufficiently seasoned by Fall for treatment. Trees cut in Fall or Winter will be ready for treating at end of Spring. Denser wood will need two or three more months than given above.

(14) The slight advantage of preliminary soaking is not warranted unless done without extra expense.

(15) Ties should be grouped for treatment when received at the plant. Only thoroughly seasoned ties should be treated.

(16) Where subjected to heavy mechanical wear, zinc chloride or light creosote treatment may be advisable. Under light traffic, heavy treatments may be advisable. Creosote is to be preferred in wet ballast.

(17) All sap wood, and as much of the heart wood as possible, should be impregnated.

(18) A dilute zinc chloride solution should be used if ties absorb a large amount, and a full impregnation given.

(19) Treating plant should be in good condition, without leaky valves or pumps. Gages and readings should be accurate and properly corrected for temperature, etc.

[In each case a charge of 25 cents per tie for tie plates and 15 cents for placement has been added to the cost of the tie, and is included in the computed annual charge.]

Species.	Estimated life.			Cost of ties.			Annual charge in track.			Annual saving of treated over untreated ties.	
	Untreated.	Treated.		Untreated.	Treated.		Untreated.	Treated.			
		10 pounds creosote per cubic foot.	½ pound $ZnCl_2$ per cubic foot.		10 pounds creosote per cubic foot.	½ pound $ZnCl_2$ per cubic foot.		10 pounds creosote per cubic foot.	½ pound $ZnCl_2$ per cubic foot.	10 pounds creosote per cubic foot.	½ pound $ZnCl_2$ per cubic foot.
	Yrs.	Yrs.	Yrs.								
Black locust	20	......	......	[2]$0.60	......	......	$0.080	......	......	......	......
Redwood	12	......	......	.53	......	......	.104	......	......	......	......
Cedar	11	......	......	.46	......	......	.103	......	......	......	......
Cypress	10	......	......	.41	......	......	.104	......	......	......	......
White oaks	8	......	......	[2].60	......	......	.155	......	......	......	......
Longleaf pine	7	20	......	[2].52	$0.89	......	.159	$0.103	......	$0.056	......
Chestnut	7	14	11	.44	.81	$0.61	.145	.122	$0.121	.023	$0.024
Douglas fir	6	15	11	.41	.78	.58	.160	.114	.118	.046	.042
Spruce	6	14	11	.49	.86	.66	.175	.127	.127	.048	.046
Western pine	5	17	12	.53	.90	.70	.215	.115	.123	.100	.092
White pine	5	14	10	.43	.80	.60	.192	.121	.129	.071	.063
Lodgepole pine	5	16	11	.46	.83	.63	.199	.113	.124	.086	.075
Tamarack	5	15	11	.41	.78	.58	.187	.114	.118	.073	.069
Hemlock	5	15	11	.33	.70	.50	.169	.106	.108	.063	.061
Red oaks	4	20	12	[2].45	.82	.62	.240	.098	.114	.142	.126
Beech	4	20	12	.36	.73	.53	.214	.090	.104	.124	.110
Maple	4	18	12	[2].45	.82	.62	.240	.104	.114	.136	.126
Gum	3	16	11	.52	.89	.69	.338	.119	.131	.219	.207

[1] Crossties purchased in 1909; Bureau of the Census.
[2] Prices quoted based on general observations.

Estimated Comparative Costs of Ties.

(20) Track scales are generally desirable for determining absorption, but cannot be depended upon if ties are steamed or boiled in oil.

(21) The preservative should be analyzed frequently.

(22) Creosoted ties not to be used immediately should be piled solidly, zinc chloride ties loosely. Zinc chloride ties should be seasoned before being placed in track to decrease leaching.

(23) Previously bored holes of proper size increase the holding power of diamond-pointed spikes and give a better penetration around the spike.

The Harriman system it is reported has awarded contracts aggregating $12,500,000, for construction of 250-mile line from Nampa, Idaho, to Winnemucca, Nev.

Contract is said to have been let by the Lorain, Ashland & Southern it is reported, for the construction of a proposed line from Lorain to Wellington, Ohio.

The Michigan Central will probably have work started in the early spring on the erection of a new roundhouse at Joliet. An addition to the present yards is also planned. This will be built opposite the plant of the Joliet Rolling Mills Co.

The Withers Construction Co., Joplin, Mo., has the contract for grading for the projected shops of the Missouri & North Arkansas at Harrison, Ark.

The House of Representatives has passed the bill extending the charter of the Newport & Sunapee, which projects an electric railway, 10 or 15 miles long, between the towns named, in New Hampshire.

The Orange & Northeastern has awarded the contract to M. Tansey for grading 6 miles of its line from Vinton to a point connecting with the Gulf, Sabine & Red River north of Vinton.

The Oklahoma Northern has been chartered with a capital stock of $50,000 and proposes to build a line from Vinita, Okla., to Coffeyville, Kan., a distance of 42 miles, at an estimated cost of $35,000 per mile. Under the terms of its charter the road is allowed to use either steam or electricity for its motive power.

PIECE WORK AS APLLIED TO THE TRACK DEPARTMENT.

C. Clay.

It is obvious that where any one thing is desired on a railway, it can usually be accomplished. The only trouble is in perfecting a system and then educating the men to use it. Piece work is not generally employed as a basis for the payment of track forces and any adaption of it would meet with great opposition, as did the split switch upon its first introduction, or any improvement for that matter. Even the bonus system cannot be said to have had a fair trial. In some places there is a bonus system, but it has not been generally employed. Piece work is even less known than the bonus system. Piece work could be employed to a great advantage, but as with other things, it could not get a fair foothold if there was great opposition to it. But we will presume that there is a railway on which it is desired to establish the work on a piece work basis and the employes are assured that it is to their advantage and are willing to co-operate. The first thing is to establish a basis for pay. This can be done by taking the force reports for a year and tabulating the work. If a mean average for a day's surfacing with an extra gang is 70-foot, then make the basis 70-foot per man on extra gang. Supposing that a section gang of four men will surface four rails in a day, their basis would be placed at 33-foot per man per day. Any figures herein mentioned should not be construed to mean actual work, as they are purely suppository and merely used to illustrate the meaning. Actual figures would serve no better purpose and would be of no use, as conditions differ with locality. If it costs $160.00 per mile to lay rail, $1.00 would not represent the cost of laying one rail except in that class of work. In this a pitfall might be found, and the preference lays with taking the average number of men and the hours they use to do a given piece of work and reduce it to one man's percentage. Having found a basis upon which to arrange our figures, the instances given being few but sufficient for illustration, there are now a number of other matters to be given attention.

If the work is paid for on the basis of the work of the gang, then there is that element of contract with the men that the companies are trying to avoid, so as to also avoid organization. However, being the simpler way, suppose it is decided to pay on the basis of the work of the gang. The supervising officials being of necessity on a monthly basis, the foreman is the first man meriting attention. With the section gang of four or five men the foreman's assistance would make a difference in the day's work, so that to a certain extent we will have to class him as a laborer in this piece work. He having time, correspondence and other matters to attend to would of necessity receive more than the laborers, but a graduated wage would merely complicate matters. As a general rule, the section foreman receives from twenty to thirty dollars a month more than the men. Therefore, pay the foreman a monthly salary of twenty-five (25) dollars, this amount increasing according to the importance of the section in proportion to his present wages, this to cover his labor on the time books, correspondence and supervision of section. Having disposed of the differential wage in this way, he receives for the balance of his wages the same rate of pay as the men. With a gang of four or five men it is necessary that the foreman should work with the men, hence the necessity of placing him partially on a basis with the other men.

And let me digress here to remark that the following would permit of all time being kept in the office, by the use of form No. 1, which will give a constant check on the time and not leave it entirely until the end of the month when of necessity it has to be handled in a hurried manner to get the pay rolls out. The foreman would have a book in which there was a duplicate and original sheet of this form 1; at the end of the day he would mail it to the office where it would be checked and entered in a book, wherein there was one page for each man. The same system as with trainmen's time could be followed in entering the time from original slip which is mailed in, the foreman retaining a duplicate for his information. The rate number would be placed there by clerk when checking to see if work was to average, each man being credited with the amount due according to the rate fixed, the number of hours also being entered. When showing the rate number, he would also show under time the amount of time allowed for that piece of work, the hours on the left hand side merely showing the relation of the time the work was done to the time that any one man worked during the day. This is merely given as an instance and the form could be amplified to suit any conditions.

In placing the time on the sheet, take the third item: If 30 feet was the average for five hours' work, then under time the clerk would write 5½, and each man would be credited with that number of hours at the pre-determined rate, presumably the same rate now paid. If, in item four, three hours are allowed for changing a point and stock rail, then the men would be credited with 3 hours instead of the four which they worked. In the case of extra gangs it would be necessary to pay all foremen, assistants or timekeepers a monthly salary, as they do not work with the gang. The average for a man having been determined, the men would re-

FORM #1

NAME		OCCUPATION	HOURS WORKED BETWEEN						TOTAL HOURS	HOURS ALLD.	RATE	DEDUCT BOARD
George Miller	1	Foreman	7 AM.	12 P.M.		1 P.M.	6 P.M.		10		15¢	
Pat Maloney	2	Laborer	7 A.M.	12 P.M.		1 P.M.	5 P.M.		9		15¢	
Jim Kelly	3	Laborer	7 A.M.	12 P.M.					5		15¢	.50
Mike Rafferty	4	Laborer	7 A.M.	12 P.M.		1 P.M.	6 P.M.		10		15¢	$1.00
Charles Curry	5	Laborer	7 A.M.	12 P.M.		1 P.M.	6 P.M.		10		15¢	
Jim Donahue	6	Laborer	7 A.M.	12 P.M.		1 P.M.	6 P.M.		10		15¢	

TIME		NO. OF MEN	Class of Work	RATE NO.	TIME EACH	ICC ACCOUNT
7 A.M.	8 A.M.	6	Take Hand Car to Work, 3 Miles			
8 A.M.	12 P.M.	1	#2 Walked Track, 6 Miles Round Trip			
8 A.M.	12 P.M.	5	Surfacing 165' Track. MP 234-3500'			
1 P.M.	5 P.M.	5	Change Switch Point and Stock Rail, Walnut			
5 P.M.	6 P.M.	4	Take Hand Car to Tool House, 3 Miles			

Note:- Foremen will leave columns "Hours Allowed", "Rate No.", "Time Each" and "ICC Account" blank. These to be filled in at the proper office.

(Form to be amplified to cover average number of men employed, on sections)

Form No. 1.

ceive pay in relation to the day's work by the gang, as compared to the average for one man for one day's work multiplied by the number of men in a gang. As an instance, where there are 60 men in the gang and the average is considered 70-foot per day, if the gang surfaced 4,200 feet, each man would be credited with 10 hours, but if they only surfaced 3,990 each man would only get 9½ hours, or if 4,410 feet surfaced each man would get 10½ hours. By handling in this manner, all of the bookkeeping with reference to time is taken from the foreman and handled in the office. In addition the men are paid for actual work performed and this is an incentive to more work.

But when you give men an incentive to turn out more work, there is an added incentive to skimp work and a close supervision would be necessary to see this was not done. After a superficial glance at this, one might say the poor man is paid the same as the good man, but that can be left to the men in the gang. If there was a poor man in the gang the other men would insist on his removal as they would feel the effect of his failure to work.

The foregoing is of course a compromise between straight pay, bonus system and piece work system, so that there would not be too great a difference between the present straight pay to cause complications and yet the men would receive an impetus and more work would be accomplished, and if properly supervised the same class if not better work.

If a straight piece work basis is desired the average would be figured out in the same way from the past year's work and form No. 2 could be used for reporting the work. In this each man gets paid for each foot of work accomplished by himself and where there was a piece of work such as replacing a frog where the full section gang was required complications would result. Where the four men with the foreman surfacd 165 feet of track which of necessity they would have to do together, it would be necessary to divide the total so each man would get an equal share and this would be done by the foreman. In changing a frog the foreman would have to show one-fifth time for each man changing frog as there were five men present.

A third system might be used, that of paying on the now accepted basis for such work as replacing frogs, switches and such work where the gang would have to all work together and paying for other work, as dressing ballast, cutting weeds and general cleaning or tightening bolts on the individual or piece work system. This would naturally be more complicated than either straight pay or piece work entirely. The foreman would have to be paid a straight monthly salary or his time would be complicated and it would necessitate two separate records to be consolidated at the end of the month to obtain the amount of money spent in accordance with the I. C. C. classification of expenditure. For the heavy work you would figure your time as at present on the hourly basis at an hourly rate and the record of the piece work would have to be separate, owing to basis of pay being different. To figure out a form for this would only burden space as we have our present forms for straight work and those herewith for piece work; a combination would result in a form too large and cumbersome. If desired to handle only a part of the work as piece work, this could be handled by contract. But the system of farming out part of the work in contracts, gives but little satisfaction.

Now having evolved a system let us analyze the advantages and disadvantages accruing from this. It is of course pure abstract theory as we have no practical basis upon which to form our opinions. Let us take the advantages. First, we have the advantage that the more work that a man can turn out the more money he will receive. Naturally this will serve as an impetus to the men. While possibly larger sums would be spent than at present, they would represent a greater amount of work done in proportion. On a section where an average day's work was not being turned out, wages would be less and consequently slow work would show up quickly. When a man feels that he is being rewarded for his individual effort there is a better chance that he will develop into a man who will do a day's work in a day, rather than a man who puts in ten hours a day drawing time.

In the matter of time, with the daily slips, the time would be kept up to date in the office to which this was assigned. This is an important feature with the class of foremen with which one has to deal at the present time: It practically relieves the foreman of work a great deal more wearisome to the average than a day's work on track, and yet leaves him responsible for the accurate reporting of the work for which he is paid a stated salary above the wage received by the men. This is a great deal simpler and more accurate than the present average way of handling time. Now as to the disadvantages, there is that which is easily presumable, where you give a man an impetus to turn out more work in the same time he will get into the habit of skimping work so that more might be turned out to his profit and also as with the bonus system, more work might be reported than was actually done; but an average supervision should soon overcome this, as such deadheading would soon show up by the amount of work done on a section. It might render necessary the employment of

FORM # 2

NAME	OCCUPATION	CLASS OF WORK	ICC ACCOUNT	AMOUNT DUE	DEDUCT
George Miller	Foreman	Take hand car to work, 3 Miles			
		1/5 Time surfacing 165', MP 234-3500'			
		1/5 Time change stock rail and point, Walnut			
		Ride home on car, 3 miles			
Pat Maloney	Laborer	Take hand car to work, 3 miles			
		Walk Track, 6 miles round trip			
		Clean switch lamps, Walnut, 2 lamps			
		Unload 2 tons station coal, Walnut			
		Pump hand car home, 3 miles			
Jim Kelly	Laborer	Take hand car to work, 3 miles			
		1/5 Time surfacing 165', M.P. 234-3500'			
					Board
					.50
Jim Donahue	Laborer	Take hand car to work, 3 miles			
		1/5 Time Surfacing 165', MP 234-3500'			
		1/5 Time change stock rail and point, Walnut			
		Ride home on car 3 miles			Board
					.75

Note:-Foremen will leave columns "ICC Account", and "Amount Due" blank, to be filled in by supervisor.

(Form to be amplified to meet number of men worked, on average section)

Form No. 2.

one more man to each district or division and he could probably be dispensed with when the system was working smoothly, but only an actual test would show this. This man would be necessary at the start to check the daily tickets, show on them the amount due for each piece of work, and make suitable entries in the necessary books. But even at that we have an increased efficiency in the handling of time to offset this, and a saving by the increased energy of the men, so that the difference his employment would make to the net saving would be small indeed.

It would appear then that the piece system could be adopted to good advantage. If it was not desired to make a change entirely at once, one district or division could be changed and the rates evolved there, as some adjustment would be necessary even after tabulation. When this district or division had the system desired running smoothly, it could be adopted by the others. This indeed would be preferable as in the experimental stage it would not be advisable to have too large a territory covered and would be easier to make the necessary adjustments. When piece work was running smoothly on that district it would be easier to adopt it to the whole railway involved and the other divisions would have some definite experience upon which to base their work.

ASSIGNING "CAUSE OF FAILURE" IN RAIL FAILURE REPORTS.

P. M. La Bach, Assistant Engineer, C., R. I. & P. Ry.

The reports of rail failures, which are now standard on railroads, all provide a clause, to be answered by the man on the ground, giving his belief as to the cause of failure. In answering this it would probably be best for the reporter to try to figure out whether a given answer is a primary or merely a secondary or contributing cause. A primary cause is one which would cause a failure if no other abnormal condition were present. A secondary cause is one which contributes to a failure where the condition is such that it would not cause a failure by itself. As an illustration, a segregated head might remain in the track a number of years with a low factor of safety, but without failing. Should there be a settlement of the track which would cause it to fail but at the same time not be serious enough to affect a sound rail, the segregation would be the primary cause, and the settlement the secondary.

From our present knowledge of the subject the three primary causes of rail failure may be called *unsoundness, defective equipment,* and *inferior maintenance.* They are of relative importance in the order named. In making this statement it is assumed that the steel is of the correct weight and section for the service imposed. Also that the ideal roadbed of uniform elasticity is properly proportioned to the loads to be carried and is well maintained. Unsoundness may be of a variety of forms, but can best be grouped under two heads: chemical and physical, as follows:

Unsoundness.

Chemical Unsoundness. (a) Improper composition for duty imposed, with particular reference to temperature and speed. (b) Segregation. (1) High carbon and other hardening materials or positive. (2) Low carbon and other hardening materials or negative.

It has been found that for high speed a tougher or more tenacious metal must be used to distribute the stresses. Although this might be called a physical characteristic, yet it can be predicated upon chemical composition. So it is usually called a chemical requirement as the variation of the composition will give different results, other things being equal.

The word segregation as here used means the separation of the different elements, composing steel, into combinations which vary from that which has been specified. When the molten metal is poured into the ingot it is presumed to be of uniform composition, but when cooling the elements which cool the least readily work towards the center and top, producing what we call segregation. When this steel is rolled, if one of the blooms has negative segregation of carbon the rail will be too soft. If it is a case of positive segregation the rail will be too brittle. When the soft and the hard are together in a limited area such as the head we will have seams developed by the unequal resistance the steel offers to the stresses to which it is subjected. Ordinarily cases of segregation can only be told by microscopic examination and chemical analysis, but a great many can be told by inspection of a fresh break. The grain of the material will not be uniform and will be coarse on one side of a seam and fine on another.

Physical Unsoundness.

(1) Pipe.
(2) Abnormal slag inclusion.
(3) Flaws due to imperfections in rolling machinery.
(4) Water cracks, caused by the use of water in rolling.
(5) Cracks and seams from cold straightening or "gagging."
(6) Internal stresses due to cooling unequally.
(7) Overheating, resulting in large grain.
(8) Excessive cold rolling.
(9) Spongy or honeycombed structure.
(10) Laps.

This looks like a formidable list, but it simply subdivides the word "flaw" which is so often used in making rail failure reports. The word "flaw" should never be used unless qualified by a statement showing just what kind is intended, and in that case it is not needed anyway. It is surprising how often it is used by trackmen and how difficult it is to tell what is intended by such a statement as "flaw in base." The more the examiner knows about steel the greater will be his inability to tell what is intended.

Pipe is a cavity which is due to the unequal shrinking of the molten metal when cooling in the ingot. This cavity is rolled into the rail and the metal does not weld together on each side. The result is a seam extending sometimes the full length of a rail. Sometimes the seam is short, only to reappear further along. It can generally be told from the split due to segregation, as it frequently extends down into the web and may be found at any point, while segregation cracks are usually where the stresses are the greatest, such as vertically over the sides of the web. The seams in any case should be described fully by diagram in a report so that its location is shown. A chemical anlysis, if made, will show in all doubtful cases what the exact trouble is.

Abnormal slag inclusion can be told from the discoloration, as the seam will be black. These are frequently called pipes by trackmen, but the above term should be used. Internal seams usually show a dark streak on top of head and should be removed when this appears.

Flaws due to imperfections in rolling machinery are seldom found when the inspection at the mills is rigid, but may escape through being covered with scale.

Water cracks are sometimes covered up in rolling and frequently take the form of a minute row of bubbles just underneath the skin.

Cracks and seams from excessive cold straightening or "gagging" are a fruitful cause of trouble. The "moon shaped" break results and frequently it will be found on careful examination that a large percentage of failures called "square" or "angular" breaks had their origin in this defect. The seam cannot be seen as a rule until it has been developed under traffic. When a square or angular break has been found, an examination for a longitudinal seam in the base should be made. If none is apparent a sledge will frequently bring it out.

The balance of the defects cannot be told readily on the ground with the exception of "laps." These are caused by rolling one part of the metal faster or slower than another and producing a seam between the two portions.

Defective Equipment.

Defective equipment includes the following:

Incorrect counterbalance.
Drivers out of round.
Flat wheels.
Broken wheels.
Worn tires or wheels causing eccentric loading of rail.
Insufficient springs.
Stiff center-bearings of trucks.

Incorrect counterbalance and drivers out of round may be suspected when there are a series of failures which correspond in intervals to the circumference of the wheel. Although there is a powerful blow delivered it is not one which will leave a mark, as a rule. While it may be suspected when sound rails break on well maintained track it usually has to be proven by circumstantial evidence, such as rails all being broken on one side of track or at certain intervals which are multiples of the circumference of the wheels.

Broken or flat wheels will generally leave a mark, if not at the point itself then up or down the track.

Worn tires overload the rail at the edges of the head and thus cause trouble. These are difficult to discover, unless it is found that the outer corner shows marks that do not occur with a normal wheel.

Insufficient springs cannot be discovered by a trackman, but stiff center bearings frequently can be, by the appearance of the rail at the end of curves. The truck does not square itself when it comes to the tangent.

Operating Causes.

Operating causes are:

Slipping of drivers.
Nosing of locomotives.
Locking of wheels by improper operation of brakes.
Excessive cold rolling due to slipping of wheels.
Excessive speed.

As a rail is made to be used it is supposed to withstand the ordinary operating forces and the above list is not intended to cover such troubles. The trackman will find evidences of these in his district. Slipping of driver causes "burnt rail." Rails so injured are apt to break due to the negative bending between the wheels. When a burnt rail is discovered it should be removed. Troubles due to excessive speed may be told on double track by the fact that on grades the down grade track will give the most trouble.

It has been found in practice that many roads which maintain their tracks in the best manner sometimes have the most difficulty with their rail. For this reason the following list of defects in maintenance should not be given as a primary cause of rail failure until it has been ascertained that the rail is a sound one and has not received any sudden blow from defective rolling stock. The enumeration serves to illustrate the multiplicity of detail in maintenance work and the necessity of doing it thoroughly. The list can also be used as a memorandum in looking for defects:

Track Maintenance.

Rail breakages due to maintenance can be charged to the following:

(a) Ties.
(1) Uneven bearing of ties.
(2) Tie plates improperly placed—not parallel to plane of truck.
(3) Ties not of uniform elasticity—decayed—soft, etc.
(4) Concave or convex tie plates.
(5) Adzing improperly done. Failure to secure even bearing.

(b) Joints.
(1) Low joints.
(2) Insulated joint splices.
(3) Loose or improperly bolted joint splices.
(4) Joint splices binding outer edge of rail base.

(c) Line and Surface.
(1) Center bound track—causing canting of rail and widening of gage.
(2) Frozen roadbed—producing inequalities.
(3) Unequal freezing of road bed—thawing on south side.
(4) Wide gage especially on curves.
(5) Poor line and surface.
(6) Inferior quality of material in substructure not compacting uniformly.
(7) Improper elevation on curves.
(8) Insufficient drainage of roadbed.
(9) Insufficient or worn out ballast.

(d) Repair work.
(1) Blows from spike maul—especially on web.
(2) Injury from track shifting machines.
(3) Reversing curvature on relaying steel.

(e) Damaged in loading at mills or unloading on the ground.

Extreme Weather Conditions.

(1) Insufficient allowance for contraction at joints.
(2) Loss of ductility due to low temperature.
(3) Bunching of rail—leaving insufficient space for contraction.

It is only in extreme cases that one reason tells the whole story. The blanks provided for reporting these matters aim to get as much of the surrounding conditions as possible. These blanks should be followed closely and carefully filled out and diagram marked. It may be that the reason for the failure may crop out after a microscopic examination but the information available at the time should be recorded as it cannot be had subsequently.

Classes of Rail Failures.

A Broken Rails.
B Segregated and Split Heads.
C Piped Rails.
D Split Webs.
E Broken Bases.

(A) Broken Rails.
(1) Square—
May be due to either shear (short length beam) or bending (large beam). Generally caused by a sudden blow, brittleness, or settlement of track.
(2) Angular.—This is a characteristic shear failure, theoretically due to a rigid or unequal support. May be caused by same as (1).
(3) Breaks starting in head and progressing downward. These breaks are due to the negative bending between the wheel contacts. As this negative bending moment is much less than the positive it is usually accompanied by less of ductility in the head due to cold rolling of the wheels, burnt rail, etc.
(4) Transverse fissures.
This is a new form which is not well understood at present. It is generally accompanied by some impurity in the steel. The tension due to the pull of the drives and also to the negative bending moment seems to develop it gradually.

(B) Split Heads due to segregation.
Of the aggregate, head failures predominate (of this and the preceding classification). This segregation

may be brought about in the cooling of the ingot and sometimes by a slag inclusive. Also streaks of carbon or some of the other elements found in steel may separate the head into several parts. This class of failure is generally developed gradually by transverse cold rolling of the wheels and impact. A dark streak is usually found along the head of a rail which is either failing from pipe or segregation.

(C) Piped Rails.

These are due to the pipe or shrinkage cavities in the ingot and are a fault of mill practices. They are greater in long than in short ingots. The Harmet process is being used to eliminate the trouble in Germany and the subject is receiving extensive study in this country.

(D) Split Webs. Generally due to pipe or segregation. Sometimes caused by initial stresses in cooling.

(E) Broken Bases.—These generally originate in a seam which has its origin in gagging at the mills or a fold in the skin worked into the base by the rolling process.

It is of considerable interest, in finding the mechanical cause of failure to know whether the failure started in the head or base. This can be told by a point from which valleys or corregations radiate. In Proceedings of Am. Ry. Engr. Assn., Vol. 12, part 2, page 425, will be found a cut showing failure starting in center of head.

With The Manufacturers

TWO MOTOR-OPERATED LIFT BRIDGES, N. Y. N. H. & H. R. R.

Practically all the railroad lift or draw bridges erected in the last few years where electric current is available, are motor operated. Experience has proven that motors are as reliable as any other form of drive. They are more economical as there is no maintenance expense when the bridge is not being operated. The control of motor drive is simpler than that of any other form of drive.

Two interesting installations of motor-operated railroad bridges are those that carry the six tracks of the Harlem River branch of the New York, New Haven and Hartford R. R. over the Bronx and the Hutchinson rivers and over which approximately two hundred trains pass daily. These bridges have been in successful operation now for several years and afford an example of the reliability of electric drive.

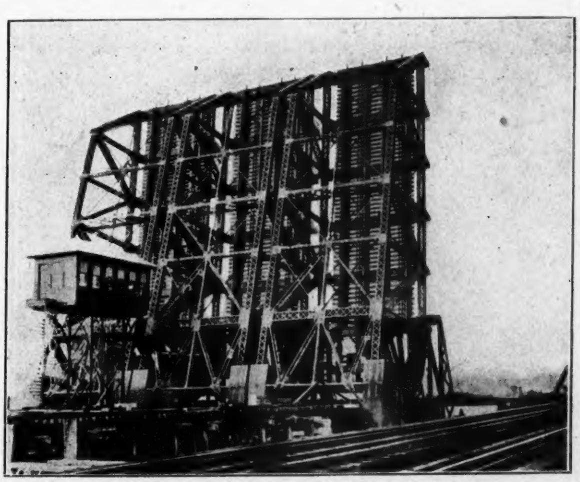
Each bridge is made up of three leaves; each leaf carries two of the six tracks. The Bronx River bridge (numbered 3.40) is near the Westchester Ave. station; The Hutchinson River bridge (numbered 7.73) is between the Baychester and Bartow stations. Both are Scherzer rolling lift bridges.

Since the channels spanned by these bridges are only about 100 feet wide, the rolling lift construction was adopted, because this type involves no narrowing of the channel. Fig. 1 shows the three leaves of the bridge 3.40 open, and Fig. 2 shows a detail of the "ways" upon which one leaf rolls; bridge 7.73 is similar in construction. The number of daily openings varies, averaging five in the case of bridge 3.40 during winter months and 12 during other months. The number of openings of bridge 7.73 is less.

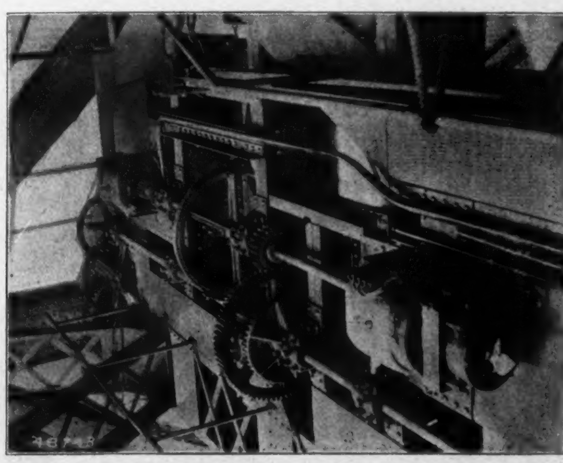
Each leaf is operated by two Westinghouse 25 H. P. 550 volt, direct current motors mounted on the moving leaf and geared to pinions which project from the side and mesh with racks on the stationary part of the bridge. Under ordinary circumstances the two motors on each leaf are operated together as one unit, but either can be controlled separately and either has sufficient capacity to move its leaf, although of course more slowly than if the two motors are working together. Both motors are provided with an electric brake and each leaf has a separate emergency brake.

The motors, brakes, and other apparatus on the bridge itself are weatherproof, and designed for successful operation through an angle of 90 degrees, through which angle the bridge moves vertically. The conduit carrying the current to the moving part of the bridge can be seen near the lower left-hand side of Fig. 2, passing to the upper side of the roll-way, and, (when the bridge is open, as shown) lying along a trench to the point where the conduit is carried up into the bridge itself. As the bridge swings down, the point where the cables enter the leaf moves upward, and the slack cable rises out of the trench.

The bridge is controlled from the signal tower. Before opening the bridge, the signals and derails are set against trains, and then the bridge rail lock mechanisms are released. The controllers are then operated and the upward movement of the bridge begins. At four points in its travel,



6-Track Scherzer Rolling Lift Spans Over the Bronx River, N. Y., N. H. & H. R. R.



Westinghouse Motors, and Power Application, Bronx River Bridge.

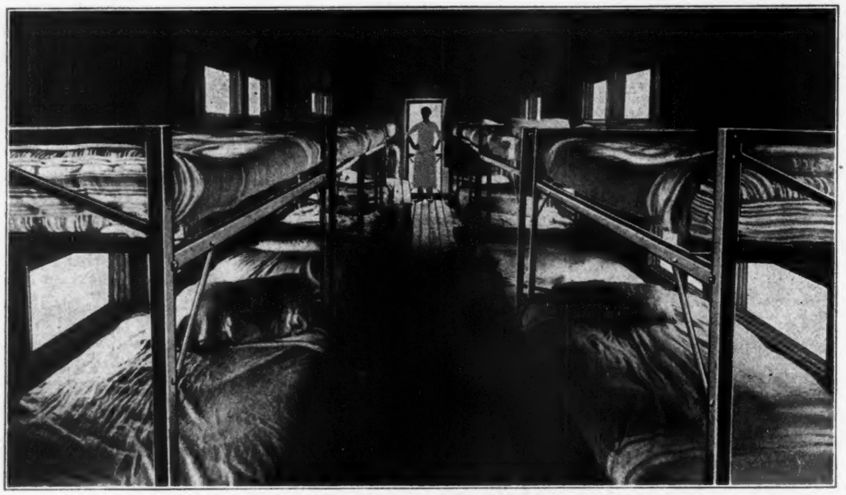
signal lamps are lighted and bells are rung. If the power is not shut off when the leaves are at the proper height, a circuit breaker is tripped automatically. When the bridge is open, the navigation lights on the river change from red to green.

The leaves are arranged in case of emergency to be manually operated by means of an endless chain over a wheel on the counter shaft. Considerable time is required for this and it has never been necessary since either of the bridges were put into service.

The motors and complete electrical equipment for this bridge were furnished and installed by the Westinghouse Electric & Manufacturing Company.

STEEL BUNKS.

It is conceded by all progressive officials who have studied the subject that it is a decided economy to look to the comfort and welfare of the workmen, especially in such matters as pertain to sanitation and rapid recuperation of the energy expended in heavy manual labor.



Interior Wausau Southern Lumber Co.'s Sanitary Sleeping Car.

The advent of the steel bunk, with flexible wire link spring fabric, as illustrated herewith, has proven a boon both to the workman and to the employer, for in addition to affording the laborer the rest his system demands, it tends to keep him satisfied and at the same time gives him renewed vigor for the next day's work. These bunks are practically indestructible, can be packed and shipped flat and set up in five minutes on arrival at camp—their manifold and manifest advantage over the dirt collecting, vermin infected, wooden bunk is so apparent that comparison is useless, and, as a matter of fact, they are cheaper than the built-in wooden bunk when longevity and service are considered. Many railways are equipping their camp cars and work trains with these bunks, with the result that they succeed in getting and holding a better class of workmen.

These bunks are made in many variations of single and double deck construction by the Haggard & Marcusson Co., Chicago.

The Minnesota & International will relay 25 miles of its line with heavier rails.

The Pennsylvania has awarded contracts to John A. Kelly Construction Co., Philadelphia, Pa., for the construction of three double track tunnels on the Allegheny Valley division, between Oil City and Kiskemineta's Junction, as follows: East Brady tunnel, 2,600 feet, to Arthur McMullin, N. Y., also Woodhill tunnel, 2,878 feet; 3,350-foot tunnel at Kennerdell. The total cost will be about $1,500,000.

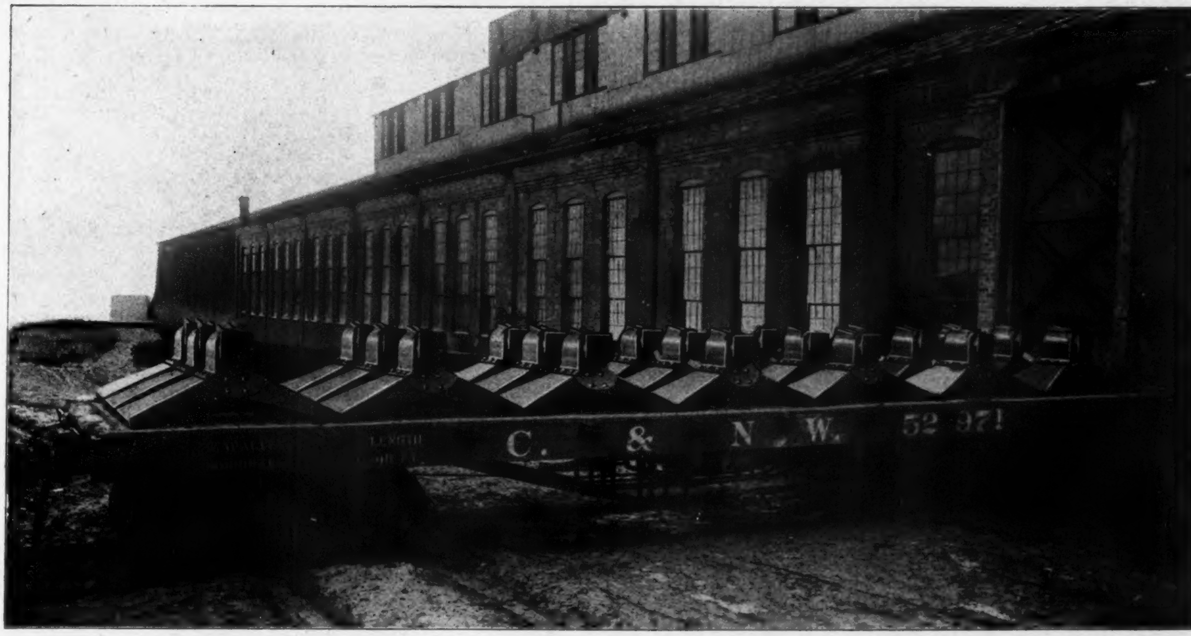
HERCULES STEEL BUMPING POST.

The steel bumping post illustrated herewith embodies the latest developments called for by the heavy service requirements of steam and electric railways. A special feature of this post is that there is no wood in its construction to rot out or decay. It is claimed that it will stand 1,150,000 foot pounds blow without damage to cars or post—they are made of 7/16 in. boiler plate steel and best grade malleable iron.

The guide stands out from the striking plate, which compels the coupler to strike the center plate and simulataneously close the coupler. The front anchors prevent the post from raising when struck, thus avoiding any damage to the track. The No. 1 type of post has 6 heavy coil steel springs, making a cushion that will receive 110,000 lbs. pressure before closing. Type No. 1 is designed for heavy freight service. No. 2 is similar to No. 1 but without the spring head. No. 3 is for passenger service with spring head. No. 4 is an elevated post with spring head. No. 5 is called the "Little Giant," and is designed for temporary track work.

The Hercules steel bumping post has earned recognition as being one for all general purposes. The U. S. Government having recently installed 39 of the type herewith illustrated on the Panama Canal tracks. These posts are designed for extra heavy service on the electric engine towing tracks. These tracks are wider than standard gauge, and the posts are of special design, being wider and measuring but 17½

Hercules Steel Bumping Post.



Consignment of Hercules Bumping Posts for Panama Canal.

inches to rail. Many of the large steam roads are now using them, and enquiries are being received from many foreign countries.

The Hercules steel bumping post is made and sold by the Railway & Traction Supply Co., of Chicago, which concern also manufactures the Wyoming Vacuum Track Sander and the Wyoming Automatic Curtain Release. The business of the company has grown to such proportions that it was found necessary to materially enlarge its facilities for manufacturing, and it has just concluded arrangements with the American Bridge Co. for the manufacture of the posts, which is an assurance of uniform and high quality and prompt delivery.

The Tullahoma, Lynchburg & Fayetteville has been organized and will apply for a charter soon to construct a line 32 miles long from Tullahoma to Fayetteville, Tenn., via Cumberland Springs, Lynchburg and Mulberry. The work will include several bridges, the largest span being 40 ft.

The St. Louis & San Francisco is to expend about $500,000 of betterment work on its line east of Ardmore.

It is reported that The Western Allegheny is contemplating an extension, from Kaylor, Pa., east to the Allegheny river opposite Mahoning, Pa. The distance is about seven miles.

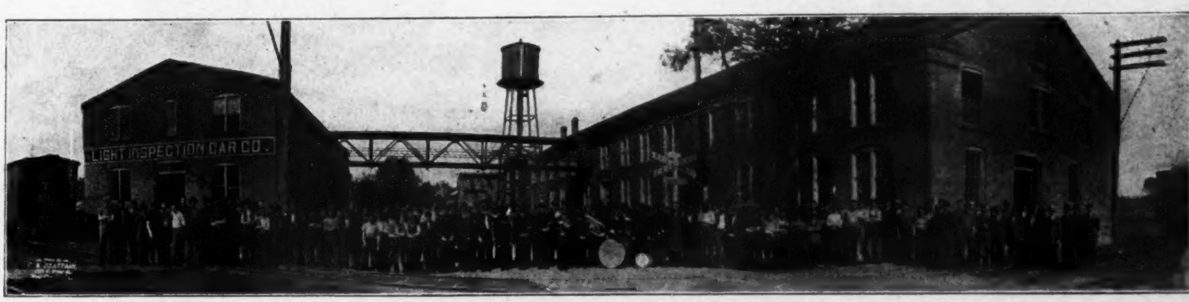
LIGHT INSPECTION CARS

One of the illustrations herewith shows the factory, a group of employes and the band of the Light Inspection Car Co., of Hagerstown, Ind. Another illustration shows one of the cars designed for light inspection work manufactured by this company.

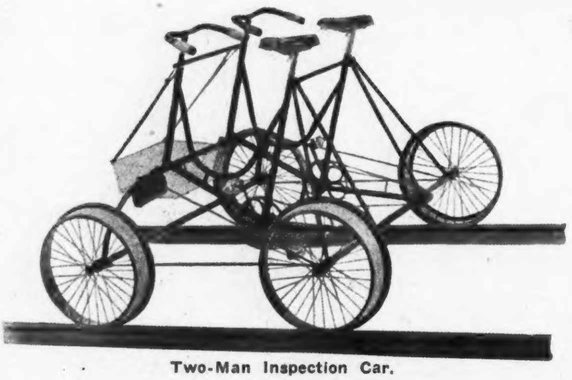
The machine in question has, on account of its somewhat unique construction, attracted considerable attention and it has been found very successful in the class of service for which it is designed. The cars are built for either one or two persons and an extra seat for a third person can be fitted.

The single seated car is built for any gauge track from 18 in. to 6 ft. When made for standard gauge, or wider, the machine is arranged so that the front axle and wheels fold back under the car thus reducing the space occupied in storing or shipping. Folding is not often required, however, as the car will pass through the door of a baggage car without folding. In cars of less than standard gauge no provision is made for folding them.

The cars are very safe and strong, but the rigidity of frame and endurance are increased as the gauge is narrowed. This adapts the car especially to rough logging, mining and mountain railways which abound in steep grades and sharp curves. They are geared to suit grade conditions, the standard gear being 62. However, 52, 58 or 73 gears can be furnished. The weight is only 65 pounds.



Plant of Light Inspection Car Co.



Two-Man Inspection Car.

The double or two-seated car can only be furnished for railways having gauges of 36 inches or over, on account of the lateral space required by pedals and gearing. It is a most convenient car for double inspection, as it allows each man a clear view of his own side of the track, divides equally the light labor of propelling the car and the seats are so placed as to render conversation easy.

This car is strong and light, with ball bearings. The weight of the riders rests well between the rails, insuring safety, and a tool bag with tools and a removable luggage basket are provided with each car. The double-seated car weighs 75 pounds.

NEW INDUSTRY FOR THE CALUMET REGION.

Another promising manufacturing plant has been added to the already large number now in the Calumet region by the location of the Calumet Supply Manufacturing Co., at Harvey, Ill.

This concern will manufacture steel cattle guards, steel fence posts, steel wing fence aprons and miscellaneous steel products for railway maintenance of way, both steam and electric.

Installation of machinery has been completed, and ample facilities have been provided for taking care of outside contracts for metal shaping work in addition to the line marketed.

Mr. H. P. Teare, until recently a member of the Century Material Co., Chicago, is vice president of the company and in active charge of its business, which is ample assurance of its success, as his years of experience in both the manufacture and sale of maintenance of way necessities, his wide acquaintance with railway officials, and his knowledge of the needs of the railways has admirably fitted him for this work. The company will maintain an office in the Karpen Bldg., Chicago, in addition to the office at Harvey.

EXHIBIT OF BELLE ISLE MOTORS.

The Concrete Form & Engine Co. will exhibit Belle Isle motors and its large roomy and powerful inspection car at the booths of the Kalamazoo Railway Supply Co. Nos. 23, 24, and 25 at the National Appliances show at the Coliseum.

W. D. Waugh, general manager of the Concrete Form & Engine Co., will be in charge of the company's exhibit.

CENTRIFUGAL TRENCH PUMP.

The trench pump illustrated herewith has some valuable features. It is designed for use when the lift is too high for a bilge pump.

The pump and gasoline engine are mounted on a rigid steel frame, which gives the engine a firm bearing. The outfit is moved from place to place without difficulty, and without disconnecting any of the parts. The pump is ready for operation the minute it reaches the job.

The engine is a 3 h. p. gasoline engine. The belt tightener can be adjusted while the pump is operating.

The outfit is built substantially and of excellent materials. It is being placed on the market by the C. H. & E. Manufacturing Co., of Milwaukee, Wis.

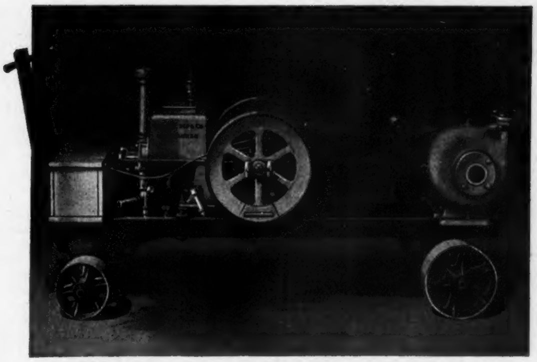
H. P. TEARE, V. P.,
Calumet Supply Mfg. Co.

Industrial Notes

At a recent meeting of the directors of the Kalamazoo Railway Supply Co., Kalamazoo, Mich., John McKinnon, heretofore general manager, was elected president. D. A. Stewart was elected treasurer and W. N. Sidnam was elected secretary at the same meeting. Mr. McKinnon's election to the presidency is a deserved recognition of the unusually successful character of his administration of the affairs of the company for the past several years.

JOHN McKINNON, President
Kalamazoo Railway Supply Co.

Rex S. Gay, formerly representative of the Ajax Forge Co. at Chicago, will, after March 1, be connected with the Verona Tool Works as assistant sales agent. His headquarters will be at Chicago.



C. H. & E. Centrifugal Pump for Unwatering Excavations.

The personal property of the Allis-Chalmers Co., Milwaukee, Wis., was bid in February 27, for $4,000,000, by Fred Vogel, Jr., representing the reorganization committee. The real properties were secured by the same purchaser February 3. The sales will probably be approved by the federal court and then the committee will begin the work of reorganization.

A. H. Chave, general purchasing agent of the Canadian Car & Foundry Co., has been appointed general assistant to the executive of the company.

The Industrial Works, Bay City, Mich., has recently established a Chicago agency in charge of Burton W. Mudge & Co., in the Peoples Gas building. This office will handle in the Chicago district the well known Industrial Works line of wrecking, locomotive and freight station cranes, pile drivers, transfer tables and grab buckets

THOS. F. H. LEYDEN.
Leyden Ortseifen Co., General Contractors.

Thomas F. H. Leyden, who has been with the Geo. B. Swift Company for the past ten years, is now associated with Adolph J. Ortseifen, general contractor, in the firm of Leyden-Ortseifen Company. Mr. Leyden has had twenty-one years' experience in the building business and is thoroughly familiar with all branches of construction.

The offices of the company are in the Monadnock Building, Chicago. The firm will specialize in railway construction work, such as shops, depots, freight houses, etc., being well equipped to handle this class of business.

O. De. G. VANDERBILT, JR., Pres.,
The Weir Frog Co.

O. DeG. Vanderbilt, Jr., has been elected president of the Weir Frog Co., of Cincinnati, O., succeeding B. W. Rowe, who has been elected chairman of the board. Mr. Vanderbilt is a son-in-law of the late Col. L. C. Weir, who was once president of the Adams Express Company, and was later president of the Weir Frog Company, until his death in 1899. Mr. Vanderbilt's interests in the past have been in the East, and his headquarters at New York City, but he has spent the past four or five months in Cincinnati, taking active charge of extensive improvements. The Weir Frog Co. has lately increased its floor space for manufacturing, by about 16,000 square feet. This was done to take care of the heavy buying movement and new extensions of the railroads in its territory. The space for the storage of raw material has also been nearly doubled to accommodate the demands for quicker shipment.

The Norfolk & Western is in the market for 60 locomotives.

The Ocean Shore has ordered two Mogul locomotives from the Baldwin Locomotive Works.

The Virginia & Rainy Lake has ordered two consolidation locomotives from the Baldwin Locomotive Works.

The Wheeling & Lake Erie is said to have ordered 20 locomotives from the American Locomotive Co.

The Chicago & Western Indiana is in the market for five switching locomotives.

New Literature

The largest and most complete production catalog ever issued by the Joseph Dixon Crucible Company, Jersey City, N. J., is now being mailed to manufacturers, jobbers, purchasing agents and others interested in graphite, crucibles, paint, lubricants, pencils and the other productions of the Dixon Company. Though over one hundred pages of type and different illustrations are used, this catalog does not attempt to carry a full description of the entire Dixon line, and only a few of the many hundreds of Dixon American graphite pencils are listed. The Dixon Company attaches great value to its production catalog inasmuch as it serves to acquaint those who are already users of one form of graphite with its many other forms and uses.

Recent Engineering and Maintenance of Way Patents

GUARD RAIL CLAMP.

1,053,961—Harry R. Akers, Tyler, Tex.

This is a guard rail clamp comprising a body portion provided with a groove on its upper side, a guard rail and a main rail seated in said groove, a filler block interposed between the outer side of the main rail and said body portion, a screw mounted in the body portion engaging said filler block and operable to force the latter into engagement with the main rail, forcing blocks engaged with the adjacent inner faces of the main and guard rails respectively, the forcing block engaged with the main rail being provided with a central threaded aperture and the other forcing block being provided with a central recess in its outer face, and a spreading screw engaged in the threaded aperture and having a non-threaded portion engaged in said recess whereby the rotation of said screw in one direction will move said forcing block against the adjacent inner faces of the main and guard rails respectively.

RAILWAY SIGNAL APPARATUS.

1,054,267—David Baker, Los Angeles, Cal.

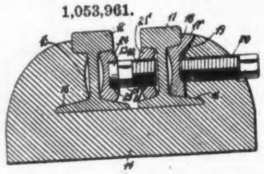
This is a railway signal apparatus for installation adjacent to a bridge over a stream. It consists of a railway including a siding track, an electrically operated signal to indicate open condition of the switch end of said siding track, an electrically operated signal to indicate closed condition of the switch end of said siding track, means to actuate the last mentioned signal when the stream rises to a predetermined level, and automatic means to break the electric circuit through the first mentioned signal when the second mentioned signal is operated.

RAILWAY TIE.

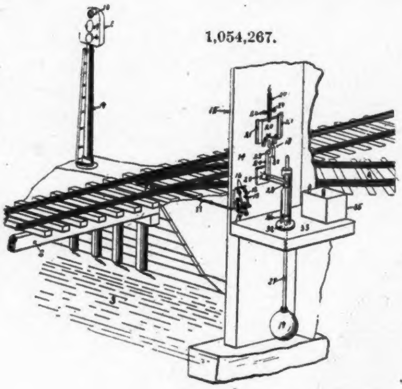
1,054,281—William Dahl, Funkstown, Md.

This is a metallic tie including block receiving members, side members connecting said block receiving members, and base plates secured to said block receiving members and having their inner ends spaced apart and their outer ends extended beyond the outer ends of the block receiving members, said base members being equal in width to the block receiving members.

1,053,961.



1,054,267.



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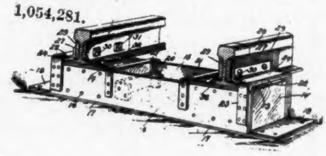
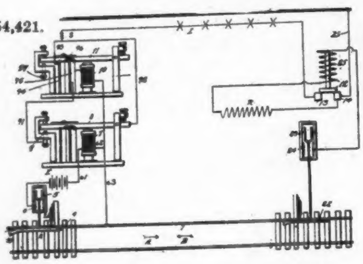
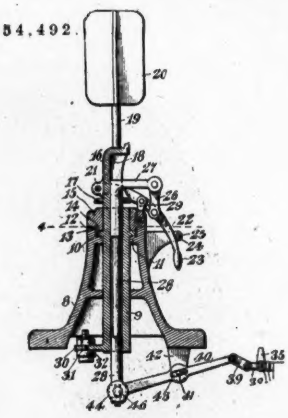


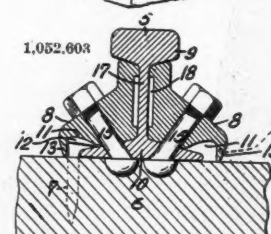
1 054,421.



1,054,492.



1,052,603



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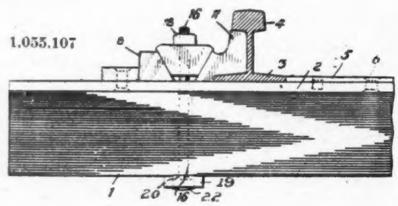
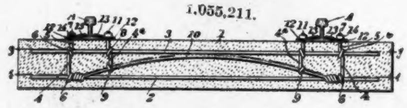


1,055,211.



RAILWAY SIGNAL.

1,054,421—Edward Jennings, Windsor, Ontario, Canada.

This is a signal system, having the combination of a trolley wire, a source of electromotive force, a pair of rails serving for traction and also as return conductors to complete the circuit through the trolley and the source of electromotive force, a conductor tapping the trolley wire and provided with two gaps and leading to one of the rails, signals in electrical connection with said conductor, a solenoid foot normally bridging one of the gaps, a connector bar adapted to bridge the other gap, but ordinarily out of contact with the conductor terminals, the said conductor being coiled at a portion that is adjacent the connector bar so as to afford a magnet for closing the connector bar across the gap, a shunt conductor leading around the gap closed by the connector bar and returning to the main conductor between the last mentioned gap and the coiled portion of the main conductor, said shunt conductor having a gap, means including a track instrument temporarily operated by a passing train for closing said gap, a conductor leading from the trolley wire and having a solenoid coil adapted to operate the solenoid foot and means including a track instrument temporarily operated by the train passing out of the block for connecting said last named conductor with a rail and energizing the solenoid to lift the solenoid foot, substantially as described.

RAILWAY SWITCH.

1,054,492—Prentice Edgar Beach, Harwood Mines, Pa.

This is a railway switch operating mechanism, switch points, a switch stand provided with a rotatable member and connections therefrom to the switch points for moving the latter to different positions, a rock shaft having lugs or fingers in position to each engage either side of a respective switch point nearer the free end thereof than the connections between the switch points and the rotatable member, a longitudinally movable and rotatable shaft concentric with the rotatable member of the switch stand, connections between said shaft and the rock shaft carrying the lugs or fingers, and an operating lever connected to the point operating rotatable member and also to the rotatable and longitudinally movable shaft connected to the switch stand.

RAILWAY SPIKE HOLDER.

1,052,603—Archibald A. MacDonald, New Glasgow, Nova Scotia. Canada.

This is a railway spike holder, a substantially triangular bar having one side thereof formed to abut the web of a rail, and the second thereof formed to abut the flange of the rail, said bar having a groove formed in the second side thereof to receive spike heads, an integral flange forming the outer wall of said groove extending below the body of the bar to approximately the level of the lower face of the rail flange, the third side on said bar being provided with recesses and apertures for the reception of attaching bolts.

ADJUSTABLE RAIL BRACE.

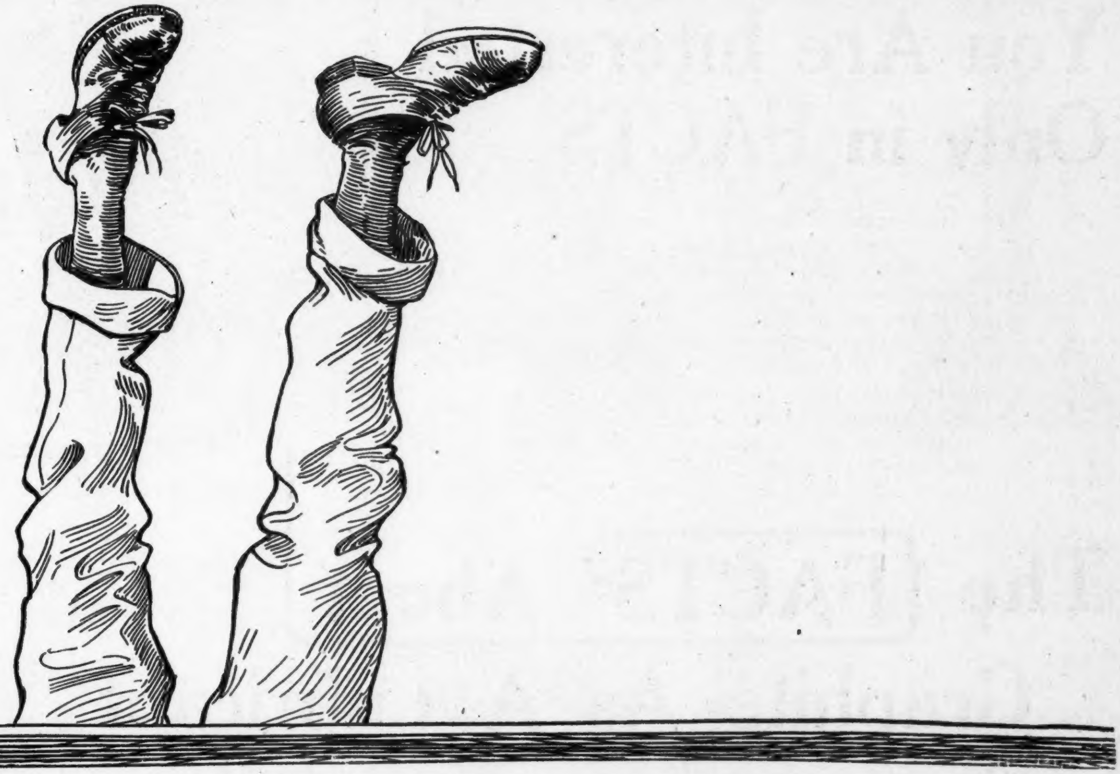
1,055,107—Joseph B. Welday, Dennison, Ohio.

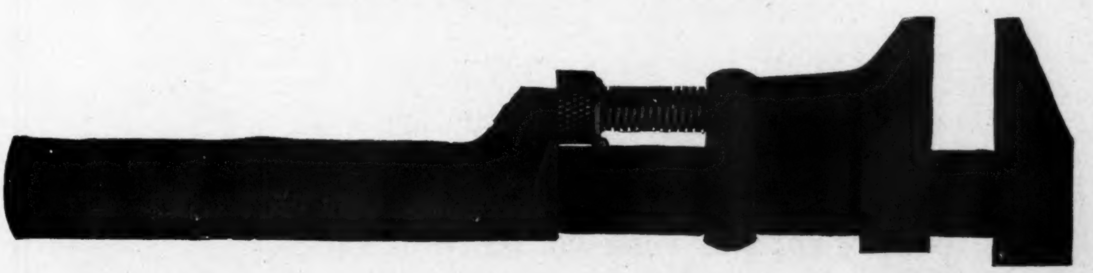
This is a rail brace having in combination, a supporting plate adapted to be secured to a tie, a rail plate connected to said supporting plate and having one end thereof forming a shoulder for the base flange of a rail, an abutment connected to said supporting plate and having one side thereof beveled and formed with shoulders, a brace member adapted to engage the web and base flange of a rail and provided with a beveled and shouldered face opposing the beveled and shouldered face of said abutment, a wedge member positioned between said beveled faces and provided with ribs engaging said shoulders, a bolt plate adapted to be positioned against the lower face of a tie and formed with slots and oblong recesses, bolts extending through said slots and having their heads seated in said recesses, said bolts further extending through said wedge member, and means mounted upon the bolts and engaging the wedge member for adjustably securing it in position.

CONCRETE TIE AND STEEL PLATE.

1,055,211—Ole J. Myers, Youngstown, Ohio.

This is a tie comprising a plastic body, a metallic frame embedded within the body and including longitudinal upper and lower bars and longitudinal arched bars, and substantially U-members connected with the longitudinal bars and including vertical legs terminally disposed beyond the rail supporting surfaces of the tie.

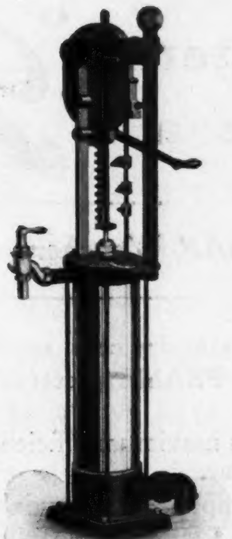




L STORAGE SYSTEMS

Cut No. 37.

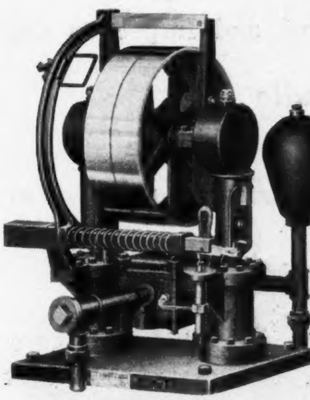
The Bowser Table Pump is especially designed for use in way stations for filling, cleaning and trimming lamps. It is very efficient as the automatic stops accurately fill the container without overflow, thus preventing waste and expediting the work. It is fire-proof, cleanly and a saver of room.



Cut No. 41.

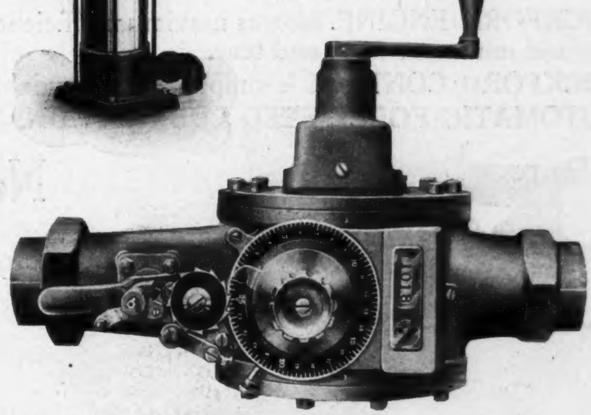
This is the Bowser Standard, Long Distance, Self-Measuring and Recording Hand Pump. It measures gallons, half-gallons, quarts or pints at a stroke and may be used in connection with above or underground tanks.

It is tireless iron clerk that intelligently handles the liquid and never makes a mistake.



Cut No. 705.

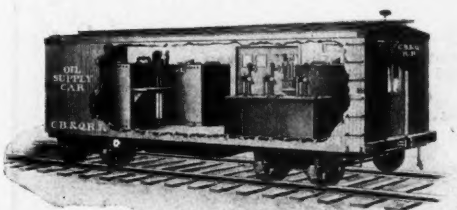
This Double Plunger Power Pump can be either belt or electrically driven. It is especially useful in connection with a Bowser Self-Registering Pipe Line Measure for quickly filling tanks, barrels, transferring oil from tank cars, etc. It is made in several styles to meet the physical needs to be overcome.



Cut No. 751.

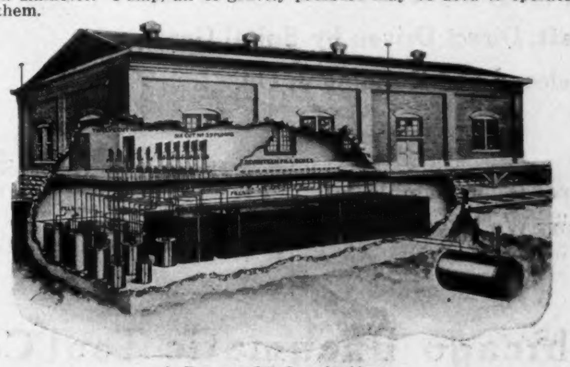
A Bowser Self-Registering Pipe Line Measure enables you to pump liquid from the place you keep it to the spot you need it in exact predetermined quantities by simply turning a valve. It is the ideal method for handling liquids at long range. There are three separate types of measures made:

1st, for simply recording the liquid as it flows through the pipe line; 2nd, for recording and setting for any predetermined quantity; 3rd, this measure does what the other two do, but it is electrically controlled and can be operated at a distance. All measures are designed for use in pipe lines from ½ to 10 inches in diameter. Pump, air or gravity pressure may be used to operate them.



Bowser Oil Supply Car.

The above illustration shows a representative installation as made for the C., B. & Q. R. R. It is one of many such installations among the other roads. It is a highly efficient way for handling expensive and elusive oils. The equipment accurately measures and records every drop of oil used.



A Bowser Oil Supply House.

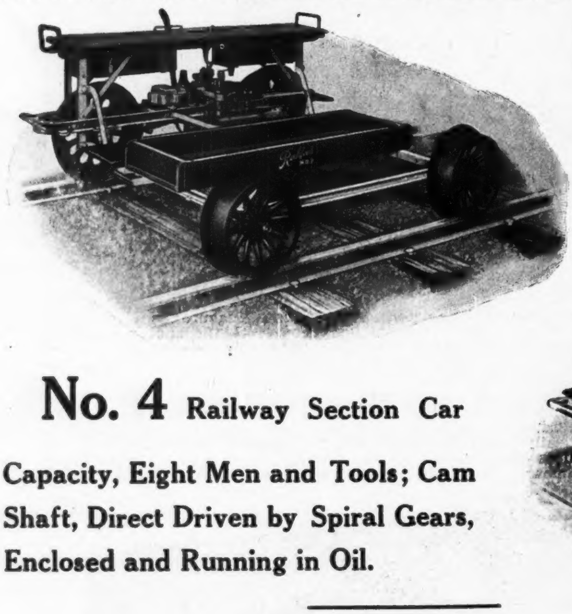
This illustration shows a representative installation of Bowser equipment in an oil supply house for the Central of Georgia R. R. It is but one of many such installations for the other railroads. We have the unqualified endorsement of every railroad management using our systems. This picture will give you an illustration why.

How's The Weather?

It Doesn't Matter If You Have a "Rockford" Magneto Car

The Car For All Weathers and Temperatures

MAGNETO IGNITION eliminates dry cells, spark coil and timer.
WELDED STEEL CHANNEL FRAME preserves alignment of crank shaft and prevents strains on engine.
ROCKFORD ENGINE insures maximum efficiency with minimum fuel consumption and minimum wear and tear.
ROCKFORD CONTROL is simple and dependable.
AUTOMATIC FORCE FEED LUBRICATION.



No. 2 Signal and Inspection Car

Easy to Handle
Easy to Operate
Easy to Pay For

No. 4 Railway Section Car

Capacity, Eight Men and Tools; Cam Shaft, Direct Driven by Spiral Gears, Enclosed and Running in Oil.

Here Is a Sample of Many We Have On File

"The car I am running now, I received May 3rd, 1910, and up to the present time I have run 3,204 miles without a breakdown or delay of any kind. Have used no repairs since I received this car. I do not think this car can be beat, and I think the Motor Car a great success."

Chicago Pneumatic Tool Company
Chicago Branches Everywhere New York
Factory, Chicago Heights, Ill.

Railroad Dept. CHICAGO PNEUMATIC TOOL CO.
I am interested in your Rockford Cars. Please send catalogue, prices and terms to.......................
Also send me Booklet 103 and let me see the Rockford Car GO BY.
RE4

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"It used to gag some of the boys," continued Jerry, "the first day it was put on and, believe me, those days came thick and fast. The blamed stuff burnt off almost as soon as it was put on.

"No, I never had any trouble on Old 689. I always used **DIXON GRAPHITE** preparation—some of the boys likes a natural gray and some a black finish and some likes a powder and others a paste—DIXON makes 'em all. Sweet and clean and always lasted from six to nine weeks.

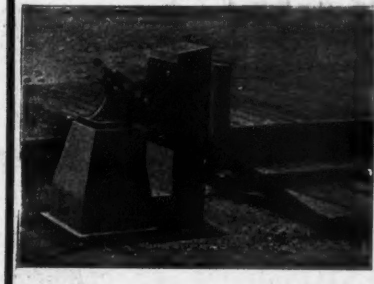
"Sure you can get a testin' sample. Write as I did and ask for folder and free sample No. 187."

Joseph Dixon Crucible Co.

Established 1827

Jersey City :: N. J.

2–F

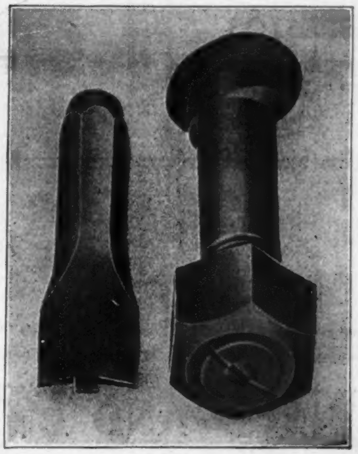


ELLIS PATENT BUMPING POST

Noted for Simplicity, Strength and Lasting Qualities. Adapted to all positions.

Mechanical Mfg. Co.,
CHICAGO, ILL.

THE CLARK NUT LOCK



Absolutely

SAFE

Absolutely

ADJUSTABLE

The Interlocking Nut & Bolt Co.
605-606 Arrot Office Bldg.
Pittsburgh, Pa.

The Trackman's Helper

Revised Edition—by J. KINDELAN

A Practical Guide for Track Foremen

Thirtieth Thousand

"It is so very plain and easily understood, its value to men of ordinary education cannot be estimated."—D. A. Dale, Roadmaster, West Shore Ry.

"I find the Revised Trackmen's Helper the most generally instructive and useful book for trackmen that is now obtainable. I think every Track Foreman and Roadmaster should have a copy of it."—D. Sweeney, Roadmaster, C., R. I. & P. Ry.

350 pages; fully illustrated, 5¼x7½ inches.
Price, $1.50, net postpaid.

Practical Switch Work

By D. H. LOVELL
Division Superintendent Pennsylvania Ry.

An Instructor and Guide for Roadmasters, Section Foremen and Construction Foremen

This book is presented in a very clear manner, which is at once simple, thorough and practical.

The contents include chapters on General Turn-outs; Stub and Split Switches; Analysis of Curves; and a large number of tables for the quick and correct construction of any switch.

Cloth, 174 pages; 4½x6¾ inches.
Price, $1.00, net postpaid.

Maintenance of Way Standards, by F. A. Smith, M. E., C. E. - Price, $1.50
Standard Turn Outs on American Railroads, by F. A. Smith - Price, 1.00
Railway Curves, by F. A. Smith - - - - - - - - - - Price, 1.00

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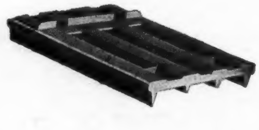
The Myron C. Clark Publishing Co.
Heisen Building, Chicago

DILWORTH, PORTER AND CO., Ltd.

PITTSBURGH, PA.

TIE PLATES AND SPIKES

GOLDIE PLATE

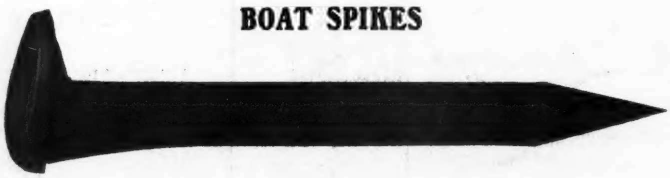


DILWORTH FLANGE PLATE

HARRIMAN PLATE

BOAT SPIKES

Standard and Special Railroad Spikes



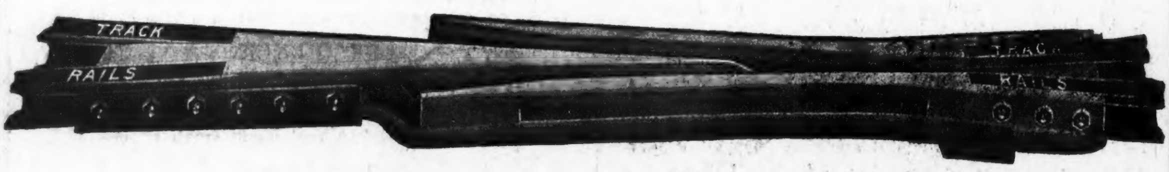
Goldie Perfect Spikes a Specialty

Send for new catalogue

"INDIANAPOLIS"

Designs of Solid Manganese Frogs and Crossings have revolutionized Maintenance and have *exclusive features* of *Merit.*

It is well to remember this.



See us at Spaces 251-2 Armory

The Indianapolis Switch & Frog Company

Springfield, Ohio

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